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Analysis of Demand and Supply for Secondary Fiber in the U.S. Paper and Paperboard Industry. Volume 1

Arthur D. Little, Inc.

Prepared For
Environmental Protection Agency

March 1976

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ANALYSIS OF DEMAND AND SUPPLY FOR SECONDARY FIBER IN THE U.S. PAPER AND PAPERBOARD INDUSTRY

Volume One

Sections I-VIII and X

Prepared for

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Environmental Protection Agency
Washington, D.C. 20460

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Attention: Project Officer
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This report will be of interest to all concerned with the economics of the pulp, paper and paperboard industry. Although no formal model of the industry is developed, a number of economic evaluations are presented. Moreover, the report presents an extensive compilation of technical and economic data on the U.S. Pulp and Paper Industry with specific attention to the role of secondary fiber. This data provides an assessment of technical and economic potential for increased secondary fiber use in the manufacture of paper and paperboard.

The report is divided into 10 Chapters plus appendix material. These chapters are as follows: (1) Summary; (2) Introduction; (3) Characteristics of the Paper Industry; (4) Wood Resource Considerations; (5) Characteristics of the Waste Paper Industry; (6) Waste Paper Costs; (7) Availability of Waste Paper;

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(8) Substitutability of Waste Paper; (9) Process Economics; and (10) Potential for Secondary Fiber Use: 1973-1983. The Appendix (Volume 3) contains six sections: (A) Regional Industry Data; (B) Supporting Data for Pulpwood; (C) Supporting Data for Waste Paper; (D) Supporting Data for Process Economics; (E) Glossary; and (F) U.S. Associations in the Paper and Allied Trades.

Volume 1 (Chapters 1-8 and 10 will be of most use to those seeking an overall appraisal of recycling and its role in the industry. Volume 2 (Chapter 9) contains detailed data on the process economics of various subsectors of the paper and paperboard industry.

Process economic data is provided for virgin, secondary fiber, and blend mills for one or more grades of paper, board, or pulp within each of the following sectors of the industry: containerboard; groundwood papers; tissue and other machine creped paper; folding boxboard; printing and writing papers; industrial packaging converting and miscellaneous papers; construction papers; market pulp; and slush pulp. Volume 3 will be of interest only to those groups seeking a more comprehensive understanding of the way in which the various process economic tabulations were compiled.

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I. SUMMARY

A. PURPOSE AND SCOPE

The principal purpose of this study is to compile a comprehensive technical and economic data bank of information on the U.S. pulp and paper industry, with specific attention to the role of secondary fiber in the industry. The data, which are presented and discussed in Sections III through IX, are intended to facilitate an assessment of the technical and economic potential for secondary fiber use in the manufacture of pulp and paper.

The study includes the following:

- Characterization of the pulp and paper industry in terms of annual sales, products, total investment, number of mills, present and future demand, plant locations, major companies, etc.;
- Analysis of the cost and availability of the wood resources to support projected pulp and paper requirements;
- Characterization of the waste paper industry in terms of its products, annual sales, investment, major companies, etc.;
- Analysis of the cost and availability of the major waste paper grades by major geographic regions;
- Analysis of the substitutability of:
    - virgin with secondary fiber,
    - paper stock grades, one for another, and
    - products made from secondary vs. virgin fiber;
- Comparison of the investment and operating cost (in new installations) for manufacturing selected paper and paperboard products from
    - virgin fiber,
    - secondary fiber, and, where applicable,
    - blends of virgin and secondary fiber.

Obviously, the economics may differ appreciably for each of these situations in existing mills.

The concluding section (X) projects the possible reuse levels that might be attained by 1983. These projections used the 1973 Capacity Survey of API as a starting point and assumed that present paper and paperboard quality would be maintained.

Finally, as directed by the Environmental Protection Agency, this report includes detailed information on each pulp and paper mill in the United States. This is tabulated in the Appendices, along with the appropriate supporting data for the corresponding segments of the report.

B. BASIS OF ASSESSMENT

This study considers the industry's activities between 1973 and 1983. Major reliance was placed on industry production and consumption data for 1973, because they represented the most complete data available at the time of writing.

Industry production capacity and fiber usage levels for 1977 were used as the base line to project waste paper usage to 1983. (The more recent data now available in the 1974 Survey indicate a significant downward revision in the waste paper use levels; however, the 1977 capacity levels are fairly well established because of the long lead time required for construction of new facilities.)

A key assumption was that the U.S. economy would begin to recover in the last half of 1975, and that there would be no further major disruption of business activities during the studied period. We did not postulate any new regulatory influences or financial incentives during this period; nor did we assume that any existing pulp mills would be idled, or that the pulping of virgin fiber would be curtailed, simply to accommodate the pulping of secondary fiber. Also, we did not postulate the selection of paper stock grades or the substitution of virgin fiber with secondary fiber at levels that would be deleterious to present paper quality characteristics.

In the preparation of the economic comparisons of Section IX, second-quarter 1974 cost and price figures were generally used. However, second-quarter 1974 selling prices for waste paper were not used, because we believed that they were not indicative of the likely long-term trends and that a cost comparison of secondary fiber with virgin fiber based on 1974 prices would produce misleading results. Accordingly, we developed cost models for the collection and baling of waste paper as an aid in forecasting its long-term selling prices.

All estimates of investment cost, operating cost, and profitability pertain to a new grass-roots facility producing a single product on a single machine. Comparing the economics of using secondary fiber instead of virgin fiber (either exclusively or in a fiber blend) in existing mills was not within the scope of this study. Had this been done, the results would more likely have reflected the constraints or advantages of specific plants, such as size and type of equipment, market opportunities, and access to waste paper resources.

A final point that should be noted in considering these cost comparisons is that none of the investment costs, operating costs, or selling prices used in this report include escalation due to inflation.

C. OVERALL FINDINGS AND CONCLUSIONS

The following statements summarize our major observations concerning the potential impact of evolving industry characteristics on the use of secondary fiber.

Although the present economic recession has slowed the trend toward greater use of secondary fiber, a number of emerging technological, economic, and social factors are combining to encourage more extensive use:

- Virgin and secondary fiber are now being blended commercially in the manufacture of newsprint and linerboard.
- The construction of new grass-roots pulp and paper manufacturing facilities based upon virgin fiber is being increasingly inhibited by the magnitude of the capital investment required.
- Nonintegrated mills, principally in the tissue and printing paper industries, have traditionally relied upon market pulp, but its high cost is giving them an incentive to seek an alternative material.
- The rapidly escalating cost of pulpwood and the rising cost of solid waste disposal (including the disposal of waste paper) are improving the competitive position of secondary fiber.
- The stigma historically associated with recycled products is disappearing.

On the other hand, as demonstrated in Section IX, the economics of paper and paperboard production (comparative production costs, selling price, and simple ROI) still favor the use of virgin fiber in most cases. Thus, if the recycling potentials indicated in this report are to be realized, the traditional investment and operating decision patterns of the domestic pulp and paper industry must change significantly.

Finally, the growth potentials for various grades of waste paper are not equal. Greater use of old corrugated boxes and newsprint is influenced by the "critical mass" -- i.e., the quantity economically accessible to support reuse of these materials. In the case of pulp substitutes and high-grade deinking, on the other hand, availability of supply is the constraining factor; and for mixed waste, limited utility of the recovered fiber is the major constraint.

D. SPECIFIC FINDINGS

1. Industry Characteristics (see Section III)

(a) Historical growth patterns and changes in the paper industry have resulted in a concentration of small, nonintegrated mills in the Northeast and North Central regions of the country. These mills have not shared in the recent increases in paper industry profitability. Since they depend on market pulp as a fiber source, their raw material costs have increased more rapidly than their product prices. The reduced availability of market pulp will maintain, or even aggravate, this condition. To the extent that nonintegrated mills continue to be economically viable, a greater use of pulp-substitute and high-quality deinking grades of waste paper may be anticipated.

(b) In many instances, smaller and older integrated facilities may have viable papermaking capacity integrated to less economically or ecologically viable pulping capacity. This is especially true in the case of small groundwood and semi-chemical pulp mills. An alternative source of fiber, such as waste paper, can encourage the maintenance of papermaking capacity despite the necessity for pulp mill closures.

(c) As paper shortages occur, users are generally prepared to accept lower quality in order to obtain the supplies they need. While lower quality is not necessarily associated with products made from secondary fiber, less stringent product specifications will tend to increase the potential for greater use of secondary fiber. Further, social changes have removed the stigma once associated with recycled products and now encourage reuse.

(d) Vertical integration of paper producers to other forest products industries and woodlands operations establishes a minimum base level of virgin fiber use which would always be economically preferable to secondary fiber pulping. A significant portion of the virgin fiber used by the paper industry comes from the residues from other forest product industries; its use is particularly economical for integrated corporations with consolidated physical facilities.

(e) Vertical integration of paper production from woodlands operations to converting operations and other end-use applications is another important aspect of overall industry structure. Historically, this integration by the major producers limited the markets available to independent paper producers, especially in the containerboard and newsprint categories. Obviously, therefore, the level of secondary fiber usage in these areas is influenced by the extent to which the large, integrated firms find waste paper economical to use as a means of supplementing their wood resources.

(f) Current market patterns and the high capital cost of new, grass-roots virgin fiber pulping facilities favor incremental capacity expansion. This kind of expansion has several advantages:

- It minimizes total capital requirements at any given time (although it does not necessarily minimize unit capital costs per ton of new production capacity).
- It protects producers from cycles of oversupply and falling prices; these have plagued the paper industry in the past, and the industry is obviously anxious to avoid them during the present period of acceptable prices and profits.

Since producers usually find it more feasible to add papermaking capacity than to add virgin fiber pulping capacity, incremental expansion will provide an increased opportunity for waste paper.

(g) The factors that discourage overexpansion also contribute to the reduced availability and high price of market pulp. This world-wide condition increases the demand for pulp-substitute grades of waste paper for both domestic reuse and exports.

2. Wood Resources (see Section IV)

(a) Pulpwood is both a by-product of and in direct competition with timber products.

(b) Competition for standing timber is likely to increase as new technology makes it economically attractive to make lumber from pole-size timber, which traditionally was used exclusively for pulpwood. Conversely, new pulpwood harvesting technology, such as whole-tree chipping in the woods, reduces the likelihood of selectively taking a few sawlogs from a pole-size timber stand.

(c) Public ownership of the commercial timberlands and growing stock is a significant feature of the U.S. wood resource. This is particularly true in the West, where 67% of the timberland and 71% of the growing stock are publicly owned.

(d) The total annual growth of timber exceeds the total annual removal in all but the Western area.

(e) Timber growth per acre could be approximately doubled in all sections by demonstrated techniques of intensive forestry management.

(f) An adequate supply of timber is available for all projected demands throughout the next decade, but better forest management practices will be required to assure the supply beyond 1985.

(g) There is considerable variation in the origin of pulpwood and the method by which it is delivered to a pulp mill. Together with the distance from the mill, these are the principal factors that influence the delivered cost.

(h) Pulpwood costs have been historically lower in the South and West than in the Northeast and North Central regions. The cost differential in these areas is likely to continue.

(i) Pulpwood costs have remained comparatively stable over the past two decades. For a variety of reasons, we do not expect this stability to continue through the next decade.

(j) We estimate that increases in pulpwood costs will exceed the overall inflation rate. Obviously, specific regional factors will be influential, but on an overall basis we believe that annual increases will exceed those due to inflation by 3-4%.

3. Characteristics of the Waste Paper Industry (see Section V)

The waste paper industry traditionally has been highly fragmented and characterized by family-owned enterprises. There is a trend for large waste paper consumers to acquire dealers who act essentially as purchasing agents for the paper mill. This move is an attempt by papermakers to establish an assured source of supply.

Another recent trend is the acquisition of independent dealers and scavengers by solid waste management firms. The acquisition of dealers is a form of forward integration to establish a sales vehicle for paper stock collected incidental to the solid waste disposal business; the acquisition of scavengers is a backward integration step to facilitate the collection of solid waste for the processing plant operated by the waste management firm.

Publicly operated waste paper collection systems are becoming an integral part of the supply channel. In some instances, town- and city-operated collection systems deal directly with a waste paper consuming mill, bypassing the dealer organization.

4. Cost and Availability of Waste Paper (see Sections VI and VII)

Historically, the costs of collecting and processing waste paper have often been greater than the selling price. The selling price structure was based on volunteer labor for the primary collection (e.g., for newsprint) or on the sale of by-product paper stock by a solid waste collector who was paid a fee to dispose of the waste material initially (e.g., for old corrugated containers and mixed waste). The price structure for pulp-substitute and high-grade deinking products is different: in this case, it is the generator that realizes income from the sale of the by-product waste material.

Because of this unique pricing structure and the fact that the potential supply generally exceeds the demand, selling prices for waste paper are highly volatile. Although prices and demand are obviously related, there is currently no valid quantitative measure of this relationship. It appears to be influenced not only by the magnitude of the increased demand, but also by the rate of increase.

The recovery of paper stock from municipal solid waste is technically feasible, but it appears economically unattractive at current prices for waste paper. The bulk of the waste paper required by the industry will continue to be generated by source segregation and separate collection systems and by the sale of paper stock by-product from a solid waste collection system.

National average recovery rates give a distorted view of the utilization of waste paper. Analysis of usage patterns shows wide variance between major geographic regions. Some regions, e.g., New England and the East North Central, have recovery rates comparable to some of the highest reported in the world. Since this situation appears to reflect a combination of demographic and industry characteristics, it is appropriate to consider these characteristics in evaluating additional opportunities.

With the exception of pulp-substitute and high-grade deinking materials, the potential overall supply of waste paper exceeds the projected demand. The populous areas of the Northeast, North Central, and Pacific (especially California) regions are major sources. There is a sufficiently large, concentrated supply of additional waste paper in these areas to make reuse economically attractive. Opportunities for economic recovery and reuse are far less in the more sparsely populated area of the South, although there are sufficient supplies in this region to support increased use of secondary fiber as a supplement to virgin fiber.

5. Substitutability of Secondary Fiber (see Section VIII)

Since secondary fiber is a by-product and a solid waste material, and hence is not manufactured to precise product specifications, we do not believe that the substitution of secondary for virgin fiber is amenable to precise analysis. The quality of the recovered secondary fiber, hence the quality of the recycled-fiber product, is influenced by:

- the characteristics of the original product,
- the history of the recovered waste paper, and
- the ability of the reprocessor to recover maximum utility from the selected grade of waste material.

There is considerable experimental and commercial experience in the use of secondary fiber in many paper and paperboard products. The constraint on greater usage more frequently involves commercial/economic considerations and not technical substitutability. For example, experimental data indicate that secondary fiber can be used in construction board products, such as insulation board and medium-density hardboard. These could be major new applications; the difficulty is apparently that they would be unsatisfactory from a commercial/economic standpoint.

6. Process Economics (See Section IX)

(a) The unit size and capital requirement for an integrated virgin fiber pulp and paper manufacturing facility are an order of magnitude larger than for one based upon secondary fiber.

(b) The calculated ROI for the manufacture of newsprint and corrugating medium from secondary fiber is about equal to or slightly greater than that associated with the use of virgin fiber. Although ROI's for some other grades (such as jute liner) are substantially lower, they appear sufficiently attractive to warrant more thorough examination. For still other grades (such as bond paper) the ROI clearly indicates that secondary fiber would not be competitive with an integrated virgin fiber mill. Blends of secondary fiber look particularly attractive for the manufacture of linerboard, newsprint, tissue, and uncoated book paper.

Table I-1 summarizes the magnitude of the capital, capital intensivity, and scale of operation for selected paper and paperboard products.

(c) The calculated ROI for some of the secondary fiber cost models is probably understated, because they are compared directly with commodity products made from virgin fiber on larger machines. In practice, the smaller machines using secondary fiber would probably be used to make the higher-

TABLE I-1

CAPITAL INTENSIVITY AND CAPITAL REQUIREMENTS FOR THE MANUFACTURE OF SELECTED PAPER AND PAPERBOARD PRODUCTS

Functional Group	Production (Metric tons) Daily	Production (Metric tons) Annual	Capital Requirements[a] $000/Daily Metric Ton	Capital Requirements[a] Total ($ Million)	Pre-Tax Return on Investment
CONTAINERBOARD					
Linerboard - Virgin	910	314,000	121	110	17.9%
- Secondary	300	100,000	100	30	8.7%
Corrug. Med. - Virgin	410	141,000	110	45	13.7%
- Secondary	300	100,000	80	24	11.8%
GROUNDWOOD PAPERS					
Newsprint - Virgin	1000	340,000	198	200	6.2%
- Secondary	300	102,000	133	40	10.6%
PRINTING & WRITING					
Bond Paper - Virgin	730	252,000	272	200	22.5%
- Secondary	136	45,000	220	30	4.2%

[a] Excluding woodlands

Source: Section IX

added-value specialty items in their respective product categories; the short duration of the machine run would tend to offset the economic advantage of the larger machines using virgin fiber.

(d) The use of secondary fiber in the various functional groups would have unequal effects on the overall level of waste paper recovery. For example, a 5% increase in the secondary fiber content of containerboard would cause a substantially higher tonnage of waste paper to be reused than a similar gain in any other functional group, because of the larger apparent demand (consumption) for containerboard.

(e) The relative importance of the various economic cost models should be recognized, since they clearly are not equally representative of the numerous products included in each functional group. For example, containerboard as a functional group represents 25.2% of total industry consumption. The two commodity grades selected for our economic models (linerboard and corrugating medium) represent 95.6% of the total functional group. Since they are commodity products, the economic models are applicable to the entire production, with the understanding that the models represent new installations and thus do not represent production costs for existing capacity.

Groundwood papers as a functional group represent 18.2% of total U.S. paper and board consumption. This functional group includes both a commodity (newsprint) as 86.1% of its total and specialty products (groundwood printing papers). Thus, our economic models for newsprint production are broadly applicable to new-capacity costs for a relatively large portion of the U.S. paper industry, whereas our uncoated groundwood printing paper models provide examples of new-capacity costs for a much smaller industry fraction.

Tissue and other machine creped paper at 4 million tons constitute 6% of the total U.S. consumption, while the specific box facial and roll toilet tissue considered in our cost model comprises roughly 45% of this functional group.

Printing and writing papers at 17.8% of total U.S. paper and board consumption are an example of specialty products. The grades selected for modeling (bond paper and uncoated book paper) represent about 43% of the total functional group. While the preceding cost models exhibit a range of quality variation, there is a wider range of quality variation within this functional group and even within the individual cost models. Accordingly, the models represent specific grades and are not applicable to the entire group. In a similar manner, the relative importance of our specific cost models varies within each remaining functional group.

(f) The manufacture of secondary fiber products from pulp-substitute grades of waste paper presents a special economic problem. Unlike OCC and old news, which appear to be in abundant supply, only limited quantities of pulp-substitute grades are available. The shortage increases their selling prices and thereby reduces the potential profitability of recycling them.

In situations where nonintegrated mills that rely upon market pulp are viable, our calculations indicate that the partial or complete substitution of secondary fiber for market pulp reduces their manufacturing costs. Nevertheless, their overall profitability is not sufficiently attractive to justify the construction of new manufacturing facilities unless new sources of high-grade deinking and pulp-substitute grades are developed (or present ones are substantially expanded) to provide a low-cost cellulosic raw material.

(g) The sensitivity analyses of the studied examples indicate that the delivered cost of fiber and the scale of operation are the key cost variables. Other assumptions and cost estimates that are included in the cost model, such as the cost of energy or the amount of fixed capital required, are comparatively insignificant.

(h) Sensitivity analyses of the derived return on investment indicate that selling price is by far the single most important variable. The mid-second-quarter 1974 prices that were used in the original calculations increased significantly in practically every category during the preparation of this report.

(i) Transportation costs account for a sizable fraction of the total delivered cost of secondary fiber. If they could be reduced--or even kept reasonably stable--by such means as optimum site selection or the consolidation of shipments in and out of the mill, the profitability of practically all the secondary fiber examples would be significantly improved.

7. Potential Waste Paper Usage (see Section X)

Figure I-1 shows, in part, the additional amount of secondary fiber that is projected to be used in each functional group by 1977. This information is based on consumption figures presented in the 1973 Capacity Survey of the American Paper Institute (API).* The consumption was apportioned among the various product groups on the basis of published data where available, or on our assessment of the categories in which the secondary fiber was likely to be used.

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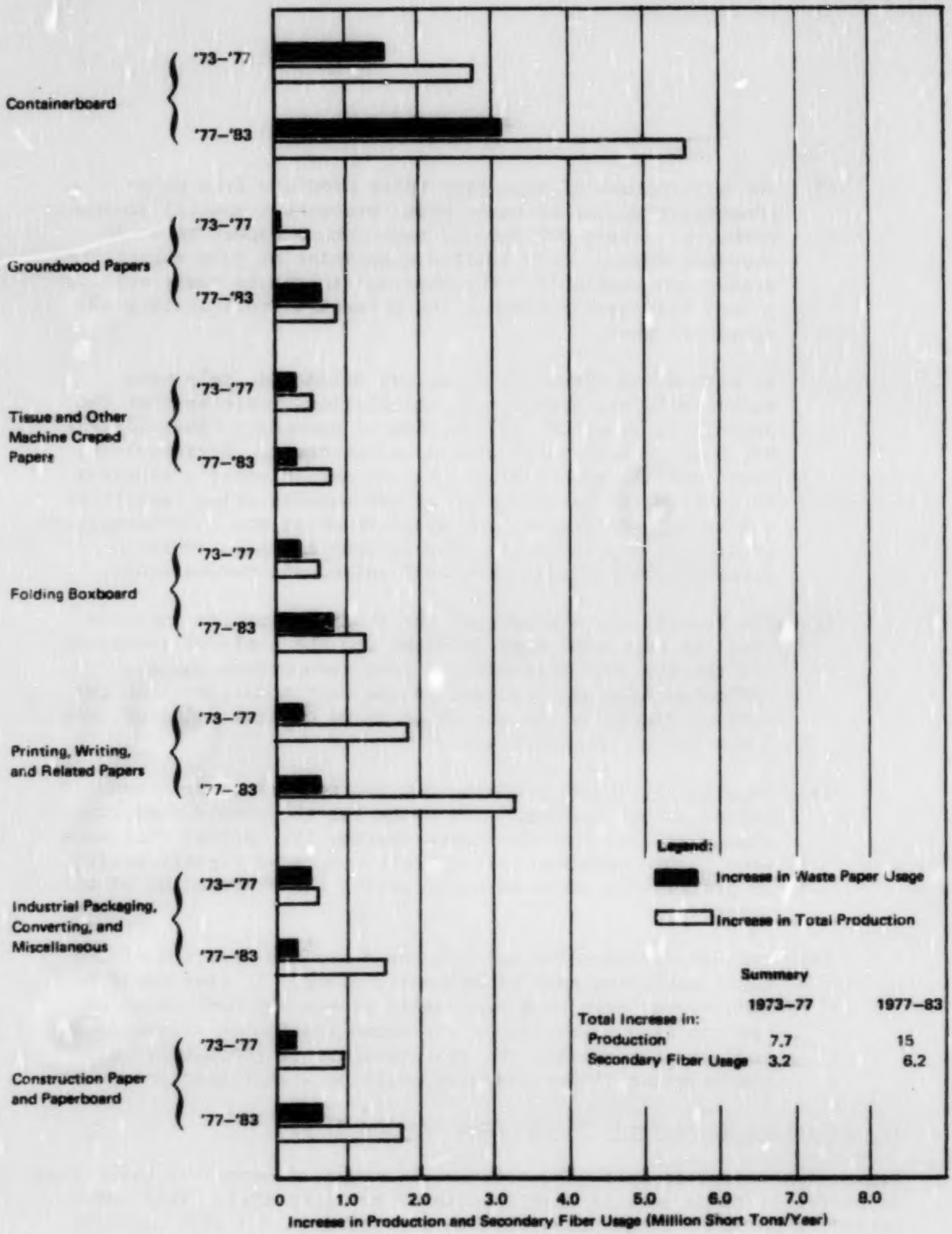
* In API's 1974 Capacity Survey, projected waste paper usage and capacity expansion are revised downward significantly.



Basis: Total Increase at End of Studied Period

Source: 1973–1977, API 1973 Capacity Survey, reaggregated by ADL; 1977–1983, ADL Projections

FIGURE I–1 COMPARISON OF POTENTIAL SECONDARY FIBER USAGE WITH PROJECTED INCREASE IN PRODUCTION

This graph also shows the increases in production that we expect by 1977. This is based on an API survey of new capacity and expansion scheduled for completion by that year. We apportioned these increases among the product groups and estimated the corresponding production in 1977.

Similarly, Figure I-1 shows our projections of the additional production requirements to meet the estimated apparent demand in 1983 and our estimates of the additional amount of secondary fiber that could be used in each functional group.

It should not be inferred from Figure I-1 that the additional secondary fiber would actually be used exclusively in new mills. The intent is simply to show how much more secondary fiber might be used in each of the studied functional groups to meet the fiber requirements resulting from the growth in demand. From this standpoint, it is irrelevant whether the secondary fiber is used in new or existing production facilities;* the key questions are (a) whether total U.S. paper and paperboard consumption will reach the estimated 75.4 million tons in 1977 and (b) whether U.S. consumption of secondary fiber will reach the total of 17.5 million tons projected by API.

The total annual production of the U.S. paper industry is projected to increase by 7.7 million tons between 1973 and 1977. The containerboard category is expected to account for some 2.7 million tons, or about 35% of this, and therefore presents one of the most attractive opportunities for secondary fiber. Between 1977 and 1983, overall U.S. production is projected to increase by an additional 15.0 million tons; we believe that containerboard will also account for 35% of this increase, or 5.5 million tons.

Secondary fiber could gain a large share of the new capacity (additional or replacement) in the containerboard category. It could also gain a larger share in the groundwood paper area because of the availability of old news to support additional production and the greater cost-competitiveness of this fiber compared with that of the alternative raw material.

On the other hand, the overall percentages of secondary fiber used in tissue and printing and writing paper may decline; this reflects our assessment that the industry is exploiting existing sources of pulp-substitute and high-grade deinking stock as rapidly as possible, leaving less reserve supplies to support expansion. However, regulations are under consideration that would require all government agencies to practice source segregation of office waste. Their enactment could significantly increase the supply of high-grade deinking waste.

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*The distribution of secondary fiber between new and existing facilities is briefly discussed in Sections X-D and X-E with respect to its two major applications -- namely, the recycling of old corrugated containers for containerboard and the use of old news in recycled newsprint.

Whereas Figure I-1 is based upon projections of increases in U.S. production, Figure I-2 illustrates the role of secondary fiber in relation to the total U.S. demand (consumption) of paper and paperboard products. Since 1973 data show historical performance, the demand represents actual paper and paperboard consumption. Estimates of secondary fiber usage in 1977 and 1983, on the other hand, assume that paper consumption will equal market demand projections for the original products. These figures reveal a substantial dissimilarity in the potential for secondary fiber penetration of the various product groups. Again, they reflect our considered opinion regarding the availability of the appropriate waste paper grade to support expansion, and the potential for recycled fiber to displace or supplement virgin fiber in each product category. For groundwood papers, the contrast between Figures I-1 and I-2 reflects the fact that about 65% of all newsprint used in this country is imported.

Figures I-1 and I-2 also point up the difference between various products with regard to their projected use of secondary fiber. In some products (containerboard, newsprint, tissue, and printing and writing papers), secondary fiber has the potential to capture additional markets; its penetration will be limited primarily by its economic availability. In such other products as folding boxboard, secondary fiber will probably not show substantial growth, as it is not expected to capture markets but simply to follow the growth of those that now exist.

Because the high per capita consumption and usage pattern of containerboard produces a concentrated supply of OCC, we expect that the utilization rate of this grade of waste paper will continue to be high. Utilization of pulp-substitute and high-grade deinking grades will also be high, due to the projected cost of virgin market pulp.

News, on the other hand, appears underutilized. As a percentage of the groundwood paper produced in the United States, however, the use of old news is projected to reach about 30%, a sharp increase from the present level of about 15%. The large amount of imported newsprint tends to obfuscate the true utilization rate of this grade.

The underutilization of mixed waste is a reflection of its limited commercial utility. For this rate to increase, cleaning techniques must be significantly improved.

In summary, secondary fiber represents a viable alternative raw material to meet the industry's future fiber requirements.

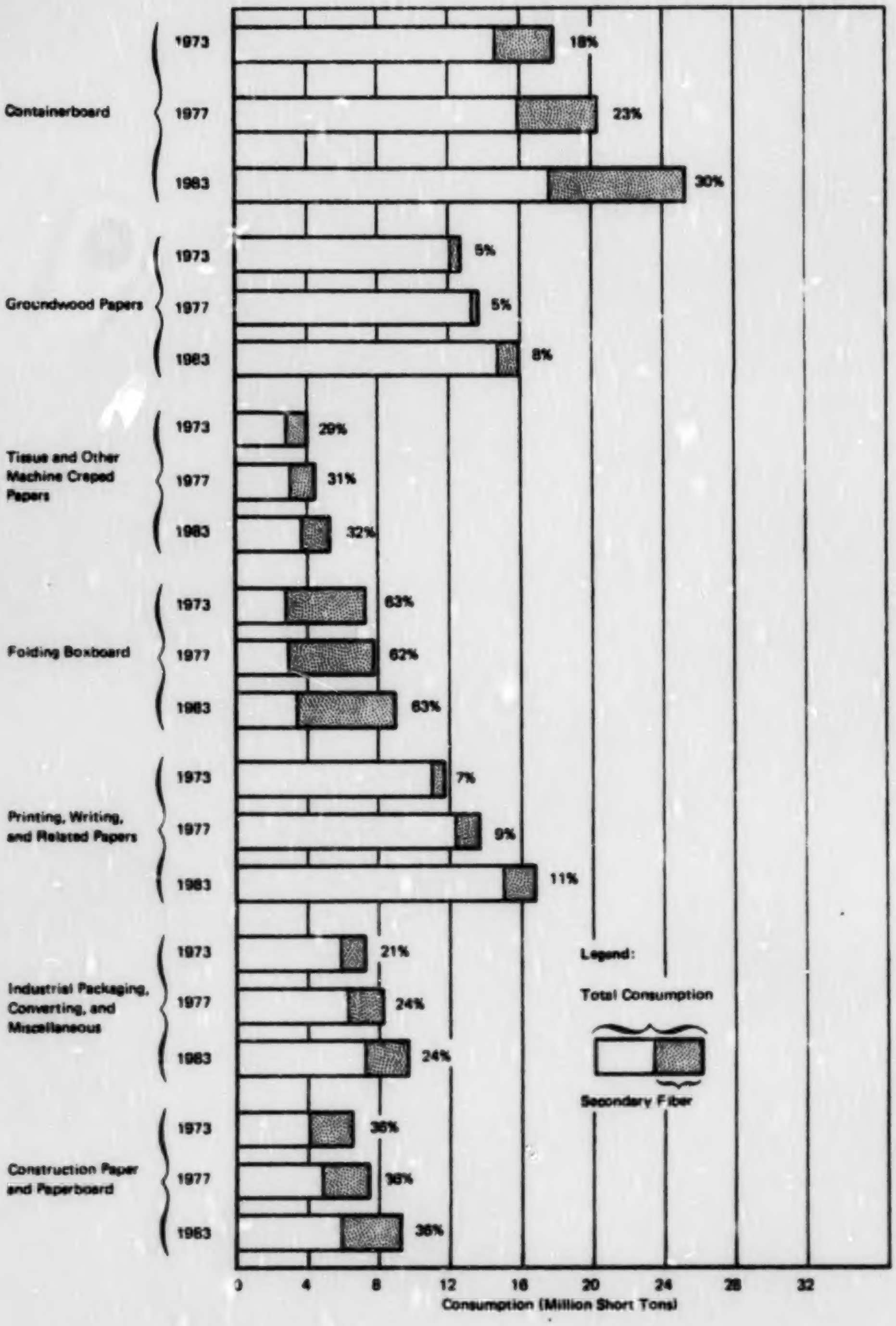

FIGURE 1–2 PRESENT AND POTENTIAL USE OF SECONDARY FIBER IN STUDIED FUNCTIONAL GROUPS

II. INTRODUCTION

A. BACKGROUND

In 1970, the United States consumed some 58 million tons of paper and paperboard products. Of this total, 9 million tons were either saved for some period in the form of books, records, etc., or lost their identity as paper (e.g., decorative laminates or sanitary tissue paper). Twelve million tons of the total were recycled, and the remainder - 37 million tons - was discarded into the solid waste stream. At present, 35% (by weight) of household trash consists of waste paper, making it by far the largest single component.

In addition to the value of recycling in reducing the solid waste disposal problem, industry experts project that after 1985 this country will be harvesting wood faster than it is being grown. The increased consumption of forest products, coupled with the removal of forest lands to fill urban requirements, is reversing the excess of growth over removals that has existed in the past.

Accordingly, an increase in the recycle ratio could greatly ameliorate the problems of solid waste disposal and loss of forest resources. Unfortunately, the percentage is apparently declining rather than rising: as recently as 1950, it was 30%, but by 1970 it had dropped to 20%. In terms of actual tonnage, however, the industry recycled more at the 20% ratio (12 million tons) than it did at the 30% ratio (8.7 million tons), because U.S. consumption of paper and paperboard doubled in the intervening 20 years.

England and Germany have reported recycle ratios of 40-45%, which has aroused some criticism of the U.S. industry. These recycle ratios, however, are based on the countries' production of paper and paperboard, and England and Germany are major importers of these products. If the percentage had been based on consumption, as in the United States, they would have changed to 27-32%.

Opportunities for profitable recycling have been reported in the literature. These publications point out that because the investment per daily ton of secondary fiber capacity is about half that for a virgin fiber mill, the operating cost of a recycling operation could be higher and still produce a more favorable return on investment than a virgin pulp mill, despite economies of scale. Such economic comparisons, of course, do not reflect quality differences and market opportunities for these recycled products.

Thus, the potential for increased secondary fiber use in this country is a complex and controversial issue. For studying preliminary opportunities, generalizations regarding the following can be of some use:

- Comparative economics of virgin vs recycled paper and paperboard manufacture;

- Potential market demand for recycled products; and
- Potential opportunities to increase secondary fiber usage.

In view of the complex and controversial nature of the problem and the social and economic impact resulting from changes in the secondary fiber usage pattern, it is imperative that EPA possess a comprehensive appraisal of the supply, demand, and opportunities for secondary fiber usage in the paper industry. The reason for EPA's sponsorship of this study was to provide a data bank of technical and economic information that would assist EPA in the accomplishment of its environmental objectives.

B. APPROACH

To carry out the objectives of this program, we relied heavily upon existing data, our own informed judgment and interpretive skills and those of consultants retained by us, and information derived from visits with selected agencies, organizations, and manufacturers.

The principal part of this program (Sections III through IX) involved the collection and organization of industry data, which included the following tasks:

- Characterization of the industry in terms of its annual sales, products, total investment, number of mills, present and future demand, plant locations, major companies, etc. (Section III);
- Analysis of the cost and availability of the wood resources to support increased pulp and paper requirements (Section IV);
- Characterization of the waste paper industry in terms of its annual sales, investment, major companies, etc. (Section V);
- Analysis of the cost and availability of the major waste paper grades by major geographic regions (Sections VI and VII);
- Analysis (in Section VIII) of the substitutability of:
    - secondary for virgin fiber;
    - paper stock grades, one for another, and
    - products made from secondary fiber as opposed to virgin fiber; and

- Economic comparison (in Section IX) of the investment and operating cost for the manufacture of selected paper and paperboard products made from

  - virgin fiber,
  - secondary fiber, and, where applicable,
  - blends of virgin and secondary fiber.

We then assessed (in Section X) how the above-listed technical and economic characteristics might influence the use of secondary fiber by the industry through 1983.

III. CHARACTERISTICS OF THE PAPER INDUSTRY

This section deals with the characteristics of the pulp and paper industry that may influence its use of waste paper. The information was obtained from published data, our industry contacts, and various trade associations.* While we have attempted to provide reasonably accurate information on individual companies, we have not developed original data for these companies since it is not critical to the overall analysis. A summary is included at the end of this section.

A. ROLE IN THE U.S. ECONOMY

1. Size and Inter-Industry Relationships

With annual sales of $31 billion in 1974, the paper and allied products industry ranked tenth among the fifteen major U.S. manufacturing industries. The industry has total assets of about $22 billion and currently employs about 718,000 people.

Because this study is aimed at an analysis of waste paper usage, we will focus our attention on the segments of the industry that produce pulp, paper and paperboard. Those that are primarily engaged in converting paper and paperboard into boxes, cartons, stationery, etc., and are not users of waste paper are excluded, except to note the segments that are significant sources of waste paper.

Tissue converting is the only exception to the exclusion of converting operations, because there is no well-established market for the interim product--the jumbo rolls off the paper machine. As a result, converting operations in the tissue sector are usually integrated with papermaking operations. For this reason, the tissue market characteristics (price, quality requirements, movement of product, etc.) are best described for the converted tissue product.

Accordingly, with the exception of tissue converting, we have focused on the pulp, paper, and paperboard sectors because the economics of their manufacturing operations will ultimately determine the level of paper recycling that can be achieved.

Figure III-1 shows the relationship of the pulp, paper and paperboard production sectors to their major supplier and consumer industries. It indicates that the paper industry's major raw materials are logs and the residues from sawmill and plywood operations, which are used to make wood pulp. Waste paper is also a significant raw material, particularly in the paperboard and building paper sectors. The chief customers are the makers of paperboard containers and boxes and a variety of converted paper and paperboard products, who sell their products primarily to the printing and publishing industry and to the consumer market through wholesale and retail channels.

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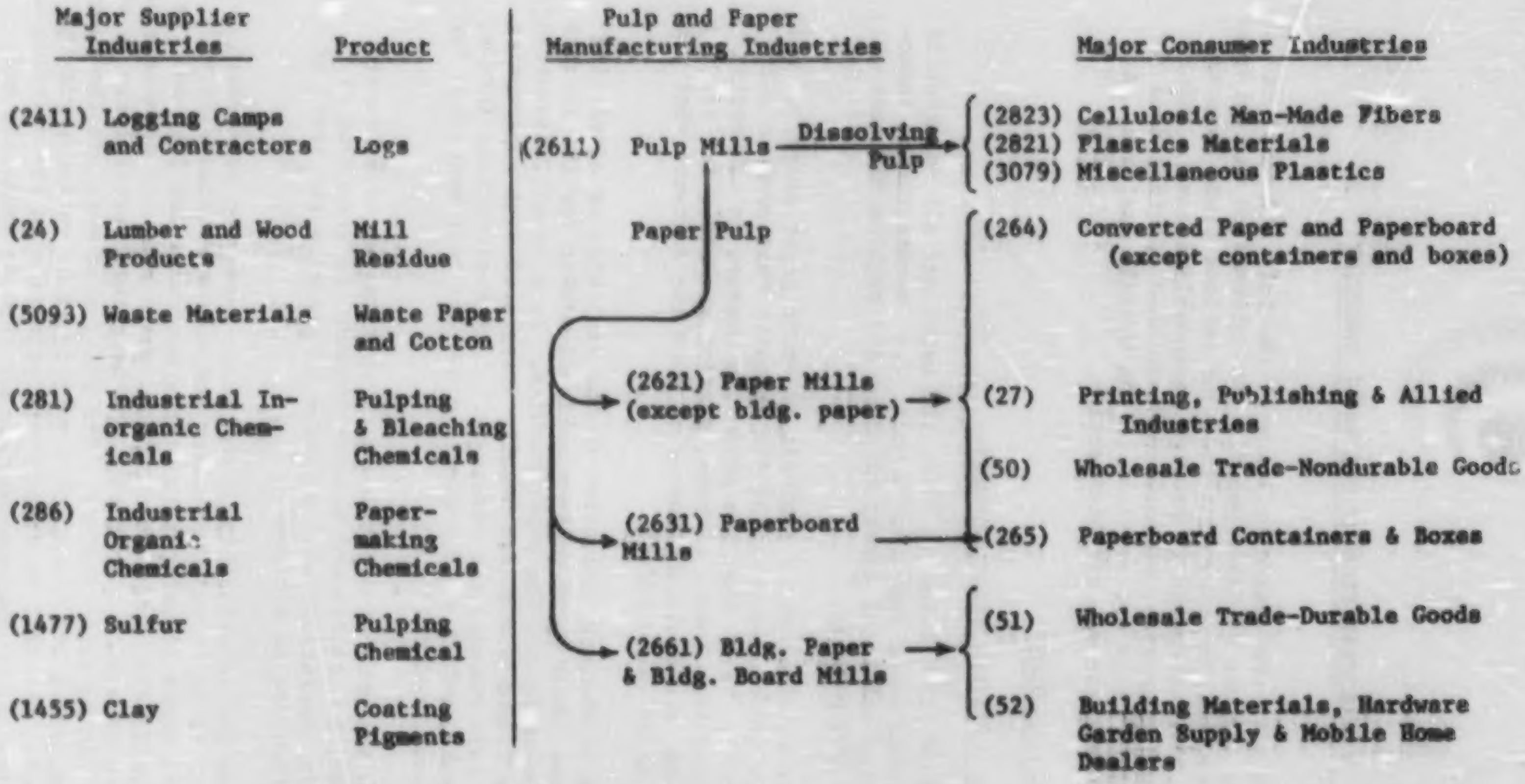
*A comprehensive list of associations in the paper and allied trades is given in Appendix F.


Major Supplier Industries
Product
Pulp and Paper Manufacturing Industries
Major Consumer Industries
(2411) Logging Camps and Contractors
Logs
(24) Lumber and Wood Products
Mill Residue
(5093) Waste Materials
Waste Paper and Cotton
(281) Industrial Inorganic Chemicals
Pulping & Bleaching Chemicals
(286) Industrial Organic Chemicals
Paper-making Chemicals
(1477) Sulfur
Pulping Chemical
(1455) Clay
Coating Pigments
(2611) Pulp Mills
Dissolving Pulp
Paper Pulp
(2621) Paper Mills (except bldg. paper)
(2631) Paperboard Mills
(2661) Bldg. Paper & Bldg. Board Mills
(2823) Celluloeic Man-Made Fibers
(2821) Plastics Materials
(3079) Miscellaneous Plastics
(264) Converted Paper and Paperboard (except containers and boxes)
(27) Printing, Publishing & Allied Industries
(50) Wholesale Trade-Nondurable Goods
(265) Paperboard Containers & Boxes
(51) Wholesale Trade-Durable Goods
(52) Building Materials, Hardware Garden Supply & Mobile Home Dealers

NOTE: Numbers in parentheses are SIC designations

SOURCE: Standard Industrial Classification Manual, 1972, Office of Management and Budget, Executive Office of the President

FIGURE III-1 MAJOR PULP AND PAPER MANUFACTURING SECTOR SUPPLIERS AND CUSTOMERS

There is a large degree of vertical integration within the pulp and paper industry. For example, companies operating pulp mills usually own or control through leases a portion of the woodlands that supply their pulpwood. Such companies also usually employ their own logging crews and often operate sawmills and plywood mills so as to obtain the highest return on their timber and to control at least part of the supply of pulpwood required for their mills. Most companies are also engaged in converting some or all of their paper and paperboard materials into boxes, stationery, etc. Few pulp and paper companies, however, are engaged in printing and publishing.

Table III-1 indicates the magnitude of the studied sectors of the pulp, paper, and paperboard industry in terms of 1972 U.S. Department of Commerce data. A total of 787 plants with gross fixed assets of about $14 billion employ about 220,000 people to produce products worth about $12 billion annually.

The largest sectors are paper mills and paperboard mills. Most of the production in both these sectors comes from mills integrated to their own on-site pulp production. However, a number of mills, particularly in the paper sector, rely on purchased "market" pulp for their raw material. All of the building paper and board mills provide their own pulp, which includes large amounts of waste paper for the production of building paper.

The so-called "market" pulp mills make either paper-grade pulp, dissolving pulp, or a combination of both. Paper-grade pulp, an interim product, is primarily sold to nonintegrated or partially integrated paper mills. Since most paper-grade pulp is bleached, it can be viewed as a competitor to the pulp substitute or deinking grade of waste paper. Dissolving pulp is not made from waste paper, because impurity problems make the process technically difficult and economically unfeasible; therefore, we have not considered the applications of dissolving pulp (primarily rayon and cellophane) in this analysis.

The paper manufacturing industry is capital-intensive, as shown by its comparatively low ranking of sales per dollar of stockholders' equity and high ranking in assets per employee (Table III-2). Within the paper industry, the market pulp sector is most capital-intensive, followed by the paperboard, paper, and building paper and board sectors.

2. Geographical Distribution

The U.S. pulp and paper industry began in New England in the 1800's with the development of groundwood pulping, sulfite pulping, and papermaking to supply the growing paper needs of the Northeast. The proximity of the expanding population centers to large resources of water and high-quality softwood pulpwood in northern New England and New York state were key contributing factors to the early development of the industry.

TABLE III-1

MAGNITUDE OF THE PULP, PAPER AND PAPERBOARD SECTORS - 1972

Sector	Number of Plants	Number of Employees	Value of Shipments ($ million)	Gross Value[a] Fixed Assets ($ million)	Shipments/ Assets Ratio
Paper Mills	358	130,000	6,400	7,600	0.84
Paperboard Mills	276	68,000	4,100	4,400	0.93
Building Paper and Board Mills	95	12,000	470	400	1.18
"Market" Pulp Mills	58	11,000	690	1,600	0.43
Total	787	221,000	11,600	14,000	0.83

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[a] 1971 data; 1972 data not yet available

SOURCE: 1972 Preliminary Census of Manufactures", U.S. Department of Commerce

TABLE III-2

INDICATORS OF PAPER INDUSTRY'S CAPITAL INTENSIVITY

Sales per Dollar of Stockholders' Equity	
Food	$4.30
Leather & leather products	3.41
Shipbuilding, railroad equip., mobile homes	3.20
Motor vehicles and parts	3.12
Apparel	3.01
Aircraft and parts	2.97
Broadcasting & motion pictures	2.96
Metal Products	2.90
Textiles	2.70
Soaps, cosmetics	2.65
Appliances, electronics	2.57
Rubber	2.56
Farm & industrial machinery	2.27
Beverages	2.25
Office machinery (incl. computers)	2.19
Publishing & printing	2.16
Chemicals	1.97
Paper and wood products	1.97
Measuring, scientific and photographic equip.	1.96
Glass, cement, gypsum, concrete	1.95
Metal manufacturing	1.83
Tobacco	1.77
Pharmaceuticals	1.72
Petroleum refining	1.51
Mining	0.78
Furniture	N.A.
Jewelry & silverware	N.A.
Musical instruments, toys, and sporting goods	N.A.
All Industries	2.48

Assets per Employee	
Petroleum refining	$126,775
Mining	84,291
Tobacco	65,158
Beverages	57,338
Broadcasting & motion pictures	48,965
Metal manufacturing	43,46[illegible]
Chemicals	38,640
Paper and wood products	36,475
Pharmaceuticals	31,353
Soaps, cosmetics	29,879
Glass, cement, gypsum, concrete	27,988
Food	27,853
Publishing and Printing	27,335
Farm and industrial machinery	24,172
Rubber	23,944
Measuring, scientific and photographic equipment	23,265
Shipbuilding, railroad equipment, mobile homes	23,151
Motor vehicles and parts	22,602
Aircraft and parts	21,562
Appliances, electronics	19,894
Office machinery (incl. computers)	19,612
Metal products	19,576
Textiles	17,094
Apparel	12,403
Leather and leather products	11,307
Furniture	N.A.
Jewelry and silverware	N.A.
Musical instruments, toys, sporting goods	N.A.
All industries	$ 27,107

SOURCE: Fortune, May 1973, p. 243

Gradually, however, the need for substantial wood supplies for pulping (as well as for lumber and plywood) outstripped the capabilities of the Northeastern area. Many of the mills, particularly those nearest the population centers, closed their pulping facilities and turned to purchased pulp or, in some cases, deinked wastepaper for their fiber requirements. As this trend was taking place, the population was moving west; the pulp and paper industry also moved westward to the North Central states and then to the Pacific Northwest and the South.

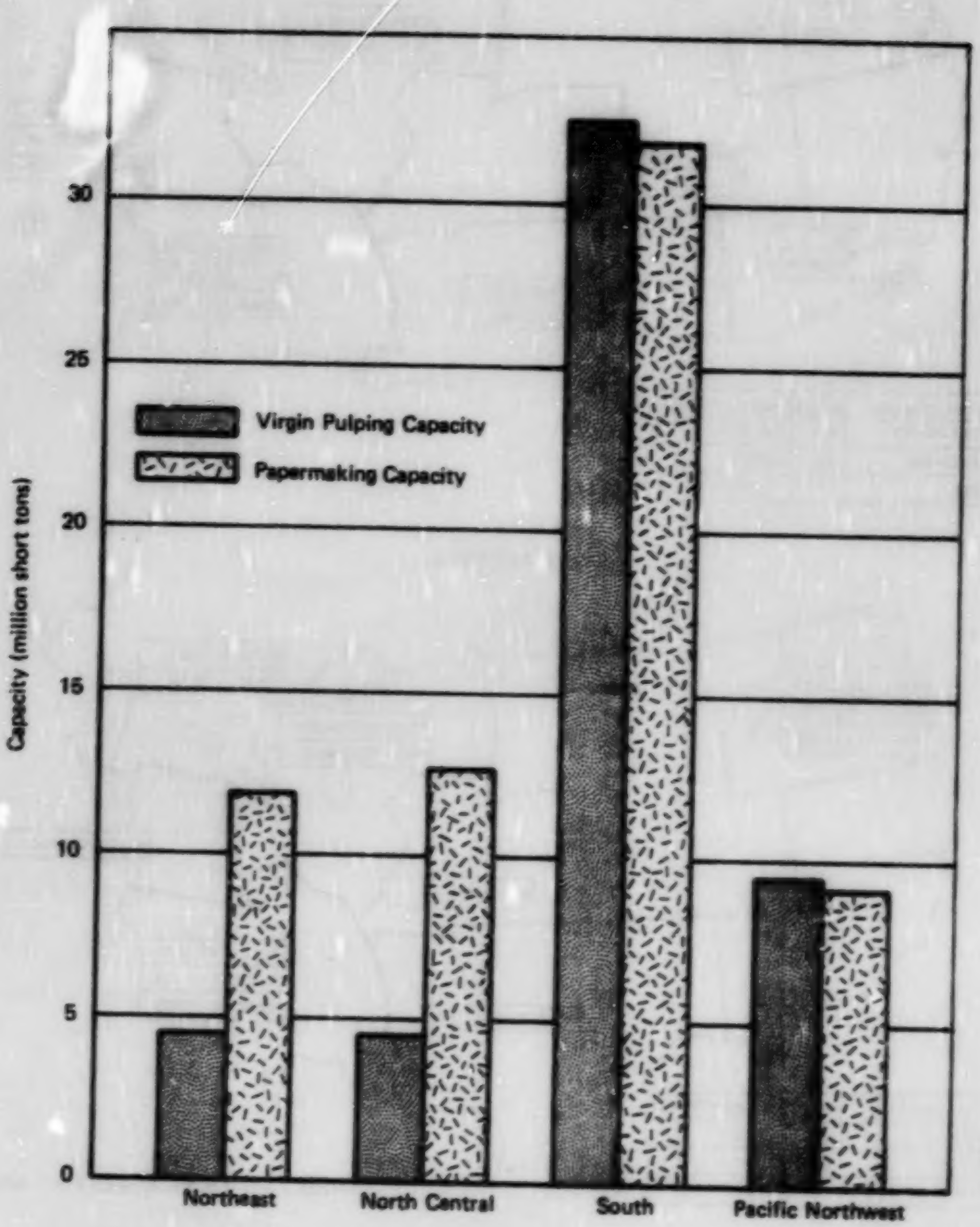
The shift to the South in the late 1930's was prompted by the development of the kraft process, which enabled mills to use the resinous wood that grows there. The industry flourished in that region because of the availability of low-cost wood, fossil fuel, and a more favorable climate for construction than in the Northeast. About 64% of the industry's pulping capacity and 49% of its papermaking capacity are now located in the South (Figure III-2).

Because of this pattern of development, the older, smaller, and nonintegrated mills tend to be located in the Northeastern and North Central states, while the newer, larger, and integrated mills are located in the South and Pacific Northwest. Figures III-3a through -3f more specifically indicate the geographic distribution of U.S. pulp and paper mills in 1973. For purposes of this industry overview, the mills are aggregated by major pulping processes; subsequently, these are aggregated by the product groups used in the analysis.

Readily apparent from Figure III-3 is the heavy concentration of kraft and NSSC pulp mills in the South, and the less extensive but still important segment of the industry in the Northeast, North Central, and Pacific Northwest. Sulfite mills are located chiefly in the Northwest and Central states. As noted earlier, many of the pulp mills that were established in the Northeast during the development of the industry have been shut down or converted to nonintegrated paper mills; accordingly, only a few isolated sulfite mills remain in the Northeast. Groundwood mills are more evenly distributed. Most recycled paper mills are in the East and North Central regions, near the metropolitan areas that provide a waste paper supply and end-use markets.

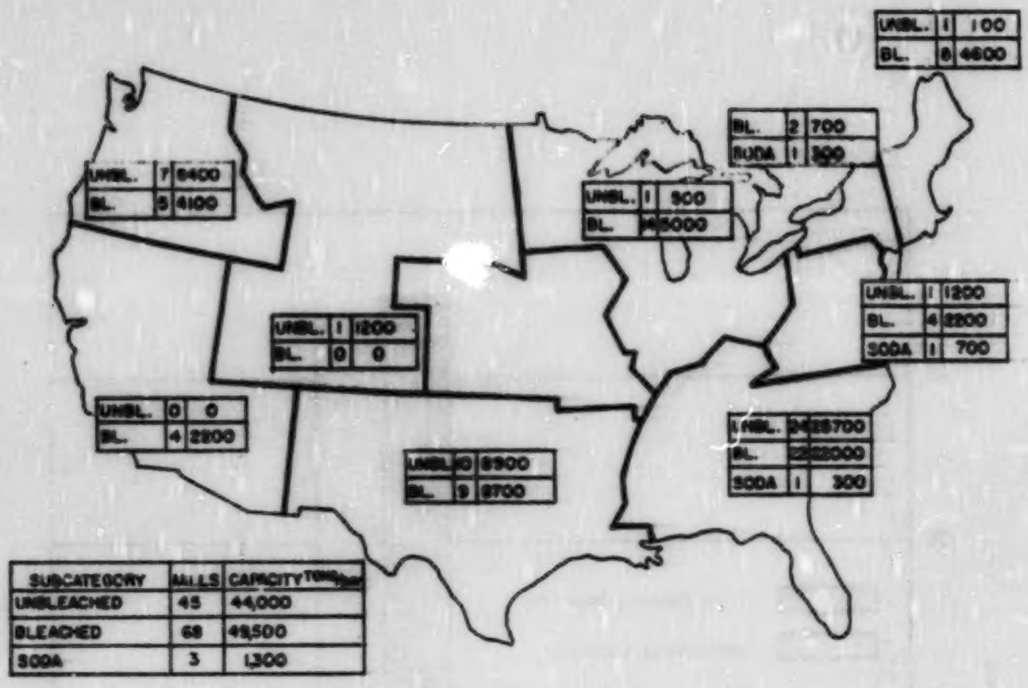
About 58% of all mills and 70% of the nonintegrated mills are in the Northeastern and North Central regions, but only 18% of the U.S. virgin pulping capacity and 38% of the papermaking capacity are located there. Secondary fiber pulping is used to augment the virgin pulp; therefore, these regions are traditionally large consumers of waste paper. As noted in Figure III-3F, many of the nonintegrated mills in these two regions produce fine paper and tissue, which are the major applications for paper-grade market pulp.

Because many of its mills are relatively small, the paper industry in the Northeastern and North Central regions tends to be more labor-intensive,



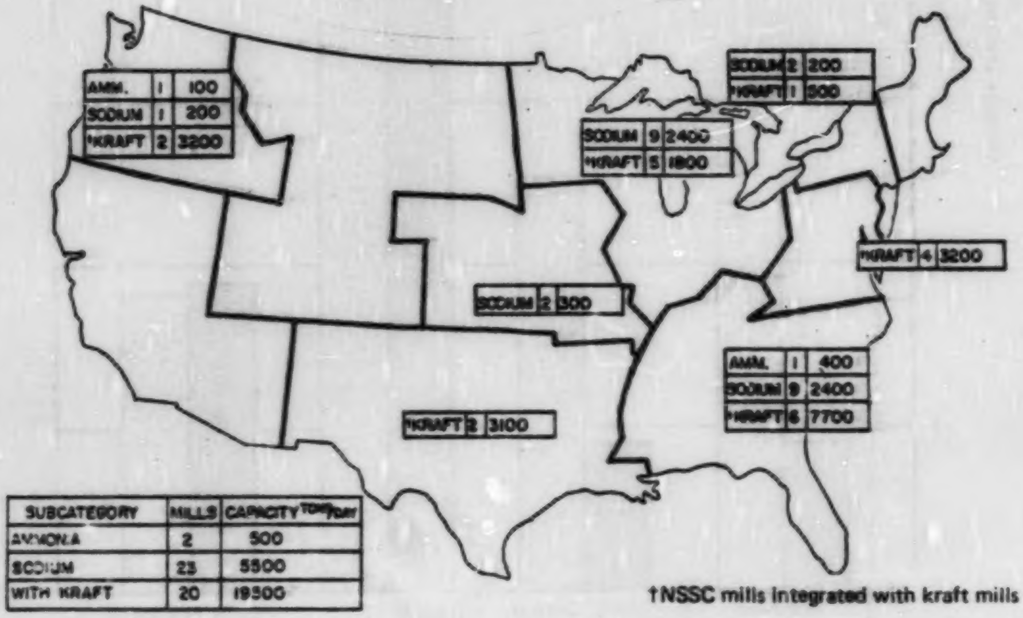
Source: "Paper/Paperboard/Wood Pulp Capacity," API.

FIGURE III–2 YEAR-END CAPACITIES FOR VIRGIN PULP AND PAPERMAKING, BY REGION – 1973


UNBL. 1 100
BL. 8 4600
UNBL. 7 6400
BL. 5 4100
BL. 2 700
SODA 1 300
UNBL. 1 300
BL. 14 5000
UNBL. 1 1200
BL. 4 2200
SODA 1 700
UNBL. 1 1200
BL. 0 0
UNBL. 0 0
BL. 4 2200
UNBL. 10 8900
BL. 9 9700
UNBL. 24 25700
BL. 22 22000
SODA 1 300

SUBCATEGORY	MILLS	CAPACITY TONS/DAY
UNBLEACHED	45	44,000
BLEACHED	68	49,500
SODA	3	1,300

A. KRAFT MILLS


AMM. 1 100
SODIUM 1 200
†KRAFT 2 3200
SODIUM 2 200
†KRAFT 1 500
SODIUM 9 2400
†KRAFT 5 1800
†KRAFT 4 3200
SODIUM 2 300
AMM. 1 400
SODIUM 9 2400
†KRAFT 6 7700
†KRAFT 2 3100

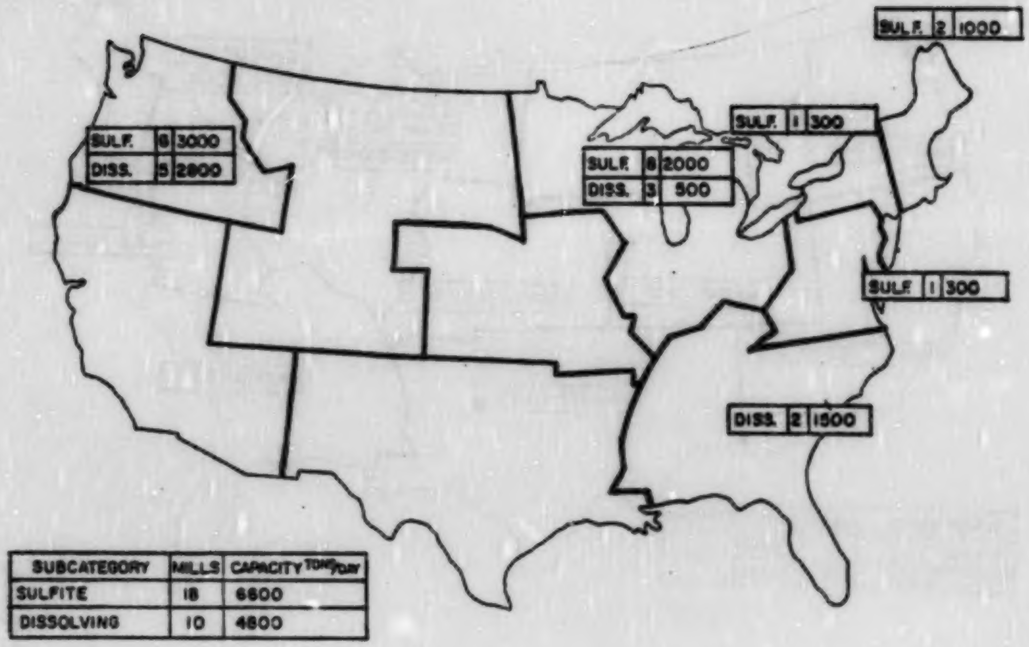
SUBCATEGORY	MILLS	CAPACITY TONS/DAY
AMMONIA	2	500
SODIUM	23	5500
WITH KRAFT	20	19500

†NSSC mills integrated with kraft mills

B. NSSC MILLS

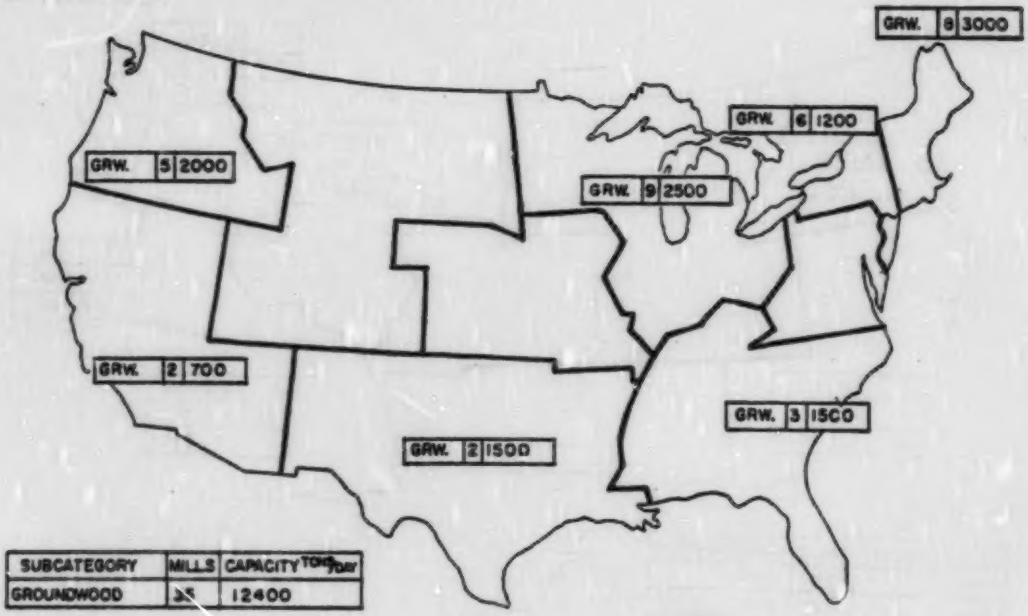
Source: "Capabilities and Cost of Technology Associated with the Achievement of the Requirements and Goals of the Federal Water Pollution Control Act Amendments of 1972 for the Pulp and Paper Industry," draft report to National Commission on Water Quality, Hazen and Sawyer, February 1975.

FIGURE III-3 GEOGRAPHICAL DISTRIBUTION OF U.S. PULP AND PAPER MILLS


SULF. 2 1000
SULF. 6 3000
DISS. 5 2800
SULF. 1 300
SULF. 8 2000
DISS. 3 500
SULF 1 300
DISS. 2 1500

SUBCATEGORY	MILLS	CAPACITY TONS/DAY
SULFITE	18	6600
DISSOLVING	10	4800

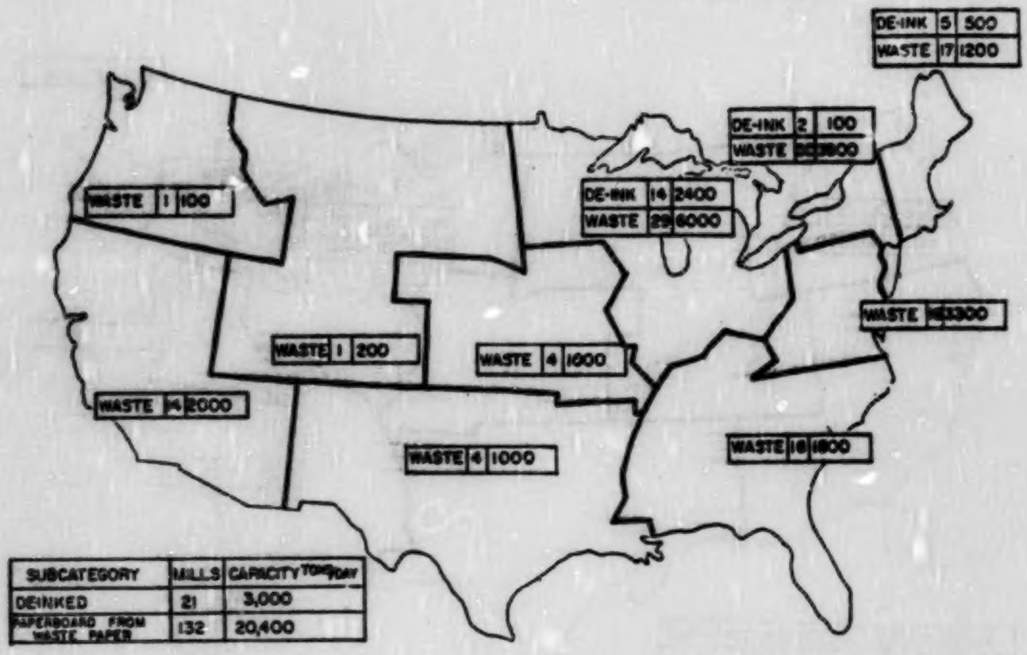
C. SULFITE MILLS


GRW. 8 3000
GRW. 6 1200
GRW. 5 2000
GRW. 9 2500
GRW. 2 700
GRW. 2 1500
GRW. 3 1500

SUBCATEGORY	MILLS	CAPACITY TONS/DAY
GROUNDWOOD	35	12400

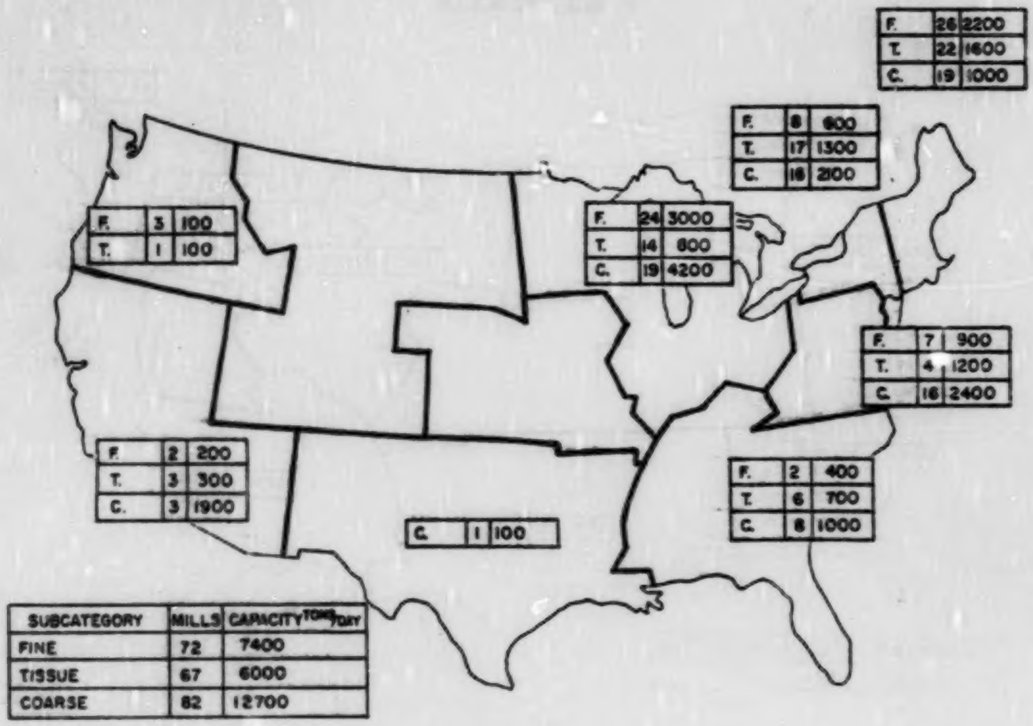
D. GROUNDWOOD MILLS

FIGURE III-3 CONTINUED


DE-INK 5 500
WASTE 17 1200
DE-INK 2 100
WASTE 20 3800
DE-INK 14 2400
WASTE 29 6000
WASTE 1 100
WASTE [illegible] 3300
WASTE 1 200
WASTE 4 1000
WASTE 14 2000
WASTE 4 1000
WASTE 16 1800

SUBCATEGORY	MILLS	CAPACITY TONS/DAY
DEINKED	21	3,000
PAPERBOARD FROM WASTE PAPER	132	20,400

E. RECYCLED MILLS


F. 26 2200
T. 22 1600
C. 19 1000
F. 8 600
T. 17 1300
C. 16 2100
F. 3 100
T. 1 100
F. 24 3000
T. 14 800
C. 19 4200
F. 7 900
T. 4 1200
C. 16 2400
F. 2 200
T. 3 300
C. 3 1900
F. 2 400
T. 6 700
C. 8 1000
C. 1 100

SUBCATEGORY	MILLS	CAPACITY TONS/DAY
FINE	72	7400
TISSUE	67	6000
COARSE	82	12700

F. NONINTEGRATED PAPER MILLS

FIGURE III-3 CONTINUED

employing about 35% and 20% respectively of the industry's labor force; the South employs about 30% and the West 15%, but each accounts for a much higher proportion of the total national production of pulp, paper and paperboard.

The industry's 787 mills are operated by approximately 450 companies. Of these firms, the top 20 account for about 65% of total production; the 50 largest produce about 85% of total output. These are typically integrated to pulp production and have annual sales of more then $50 million.

The top 20 companies generally produce at least as much papermaking pulp as they need. Usually they manufacture commodity paper and paperboard products, such as linerboard, corrugating medium, bleached board and unbleached kraft paper. Their major operations are typically in the deep South and the Pacific Northwest. Those that have owned properties in the Northeast and North Central regions for many years manufacture more specialized products, such as printing and fine papers, as well as the commodity items discussed above.

At the other end of the spectrum are the family-owned, single-mill concerns, most of which are located in the Northeastern and North Central regions and make specialty paper products in quantities ranging from less than 10 to several hundred tons per day. These producers usually rely on purchased pulp, although some operate small pulp or wastepaper deinking mills.

The medium-sized companies usually produce pulp and often are net buyers of pulp as well. These tend to concentrate on a rather narrow product range and are not as diversified as the major companies with regard to the kinds of paper and paperboard products they can supply.

The location, product line, and capacity of all U.S. mills are listed in Appendix A-1 (categorized by functional group) and Appendix A-2 (categorized by region and state). This information is summarized in Appendix A-3, which lists the number of mills in each functional group by state.

3. Profitability Trends

Very few publicly-held companies produce only pulp, paper, or paperboard without converting at least part of their production to end products. Therefore, there are no publicly available data that characterize the current profitability of only the pulp, paper and paperboard sectors of the industry. The Internal Revenue Service publishes the profitability of the pulp, paper, and paperboard sector from a composite of corporate income tax returns, but this is several years out of date when published. For much the same reason, no data are publicly available on the profitability of individual grades or product lines, since few public companies in this industry produce a single product line. Overall, however, paper and allied products industry profitability data reflect trends that are similar to those in most product sectors over the past five years (Table III-3).

TABLE III-3

PAPER AND ALLIED PRODUCTS INDUSTRY PROFITABILITY AND CAPITAL STRUCTURE (1969-1974)

		Net Profits[a]		Stockholders'
Year	Quarter	% of Sales	% of Equity	Equity/Debt
1969	I	4.7	9.8	1.89
	II	5.2	11.1	1.90
	III	4.7	9.6	1.89
	IV	4.6	9.9	1.88
1970	I	4.2	8.3	1.83
	II	3.9	8.2	1.80
	III	3.1	6.2	1.75
	IV	2.5	5.3	1.70
1971	I	2.5	4.9	1.68
	II	2.8	5.9	1.67
	III	2.5	5.3	1.66
	IV	1.4	2.9	1.75
1972[b]	I	3.0	6.5	1.79
	II	4.6	10.5	1.77
	III	3.8	8.6	1.80
	IV	4.6	10.5	1.86
1973	I	4.7	10.8	1.97
	II	5.9	14.6	1.97
	III	5.6	13.1	2.00
	IV	5.6	13.0	1.98
1974[c]	I	6.6	15.8	2.03
	II	7.9	20.5	2.07
	III	7.8	20.1	2.15

---

[a] After income taxes

[b] Revised series as of fourth quarter of 1971.

[c] Revised series as of fourth quarter of 1973.

Source: Federal Trade Commission, Quarterly Financial Report for Manufacturing Corporations.

In 1970 and 1971, the paper industry's after-tax return on sales and shareholders' equity fell to its lowest level since World War II. Coupled with low profitability, the industry's debt reached its highest level since that time, as illustrated by its equity-debt ratio of 1.66 in the third quarter of 1971.

In 1972, however, improved mill operating rates and higher prices throughout the paper industry caused an upturn in profitability. Profits continued to rise through 1973 and were particularly significant in the first and second quarters of 1974, after price controls were partially lifted for this industry in March of that year and fully lifted in June. The upturn in the industry's earnings also caused shareholders' equity to assume a larger proportion of its total capital structure.

The industry's profitability in 1974 reached its highest point since World War II and was well above the average for all industries. Market pulp profitability was above the industry average, while average paper and paperboard were below.

4. Trends that May Affect Watepaper Utilization

Since 1973, market pulp has been in short supply, and its price has risen sharply. This is partly the result of inflation, which has increased all manufacturing costs, particularly those of pulpwood and energy; also, as discussed in Section IX, the high cost of replacing existing manufacturing facilities has escalated the prices of market pulp and all other industry products.

The shortage and high cost of market pulp have served to increase the demand for the alternative raw materials, namely the pulp-substitute and high-quality deinking grades. Thus, while we do not have the 1974 waste paper consumption figures at this time, we expect them to show a sharp increase in the quantities of these waste paper grades over previous levels.

The paper industry supply/demand balance has now loosened considerably as the economic recession has dampened demand for its products. In turn, the paper industry's demand for waste paper has slackened, and waste paper prices have fallen considerably below their highs of 1974. On the other hand, prices for most of the paper industry's products (including market pulp) have remained firm, and the industry's profitability is currently holding close to the record high levels established in 1974. This is in contrast to the extremely low profitability that prevailed during 1970 and 1971.

In spite of the upturn since 1971, paper industry management has been much more cautious than in previous years in expanding capacity. The key reasons for the lower rate of capacity expansion which is foreseen through 1977 are:

- Scarcity of new or expandable mill sites;
- Difficulty and cost of obtaining additional woodland control;

- Escalating costs of mill construction;
- Difficulty and high cost of obtaining sufficient capital;
- Uncertainty over future national and world economies;
- Uncertainty over the future impact of government regulations.

The chief effect of this slower rate of expansion will be to tighten the industry's supply/demand balance as the economy recovers from the current recession. As a result, the industry's prices will continue to escalate, and its consumption of (and prices paid for) waste paper will again increase. The combination of supply constraints, rising prices, and slower U.S. economic growth will also cause domestic paper consumption and production to grow at a slower rate of 3-3.5% per year through 1983, compared with 4.5% per year in 1960-1970.

The supply/demand relationship of both pulpwood and saw timber in the United States will also become significantly tighter by 1983. This trend will cause timber stumpage prices to increase and create greater economic incentive to manage timberlands for greater growth and yields. This, in turn, will increase the economic advantage of companies controlling large blocks of timberland that support nearby pulp mills and wood conversion plants. We believe that the costs of stumpage, wood harvesting, hauling, and forest management associated with virgin pulpwood supply will increase more rapidly than the rate of inflation. (See Section IV.) The price of waste paper will also rise, but probably not as steeply as that of pulpwood; the pressure for higher prices will be somewhat alleviated by increased supplies as the practice of charging for solid waste disposal becomes more widespread.

Pressure for protecting the environment will significantly accelerate technological change in this industry. These concerns are already causing significant modernization of the industry's plant and equipment through technological improvements and industry consolidation. We expect to see increased use of lower polluting unit operations such as high-yield pulping, oxygen bleaching, high-consistency forming, and dry forming for special applications as well as greater use of waste paper raw material. On the other hand, increasingly stringent water pollution control regulations are inhibiting the use of waste paper, particularly in deinking operations, by adding to the costs of the repulped waste paper fiber.

B. INDUSTRY SEGMENTATION AND OVERALL GROWTH TRENDS

1. Industry Sectors

The paper industry comprises a variety of sub-industries built around major product categories; the latter have been classified by the American Paper

Institute (API) and the U.S. Department of Commerce according to end use and/or pulping process employed. Many products compete for the same end-use market, and this intra-industry competition must be taken into account in projecting the future supply and demand for the product categories.

In organizing this presentation, we found it useful to aggregate the numerous industry product categories into seven functional product groups. These were selected on the basis of common primary markets for the products included; in many cases the products are complementary rather than directly competitive.

Table III-4 shows the specific paper and paperboard grades that are defined by API as belonging in the selected functional group. Production data for 1973 are also included to illustrate the relative magnitude of the tonnage in the selected categories.

Subsequently, each category is discussed separately to identify its industry characteristics and the possible effect of these characteristics on the use of secondary fiber in that area.

2. Demand Projection

In this analysis, we have used the term "demand" or "consumption" to indicate the requirement for paper and paperboard products by their subsequent user, whether the latter is a converting operation or the ultimate end user. Accordingly, in converting operations that produce scrap, such as the production of corrugated boxes, the scrap factor must be subtracted from the reported consumption to obtain the output of the converting industry. Tissue is the one exception to this; as explained earlier, tissue manufacture and conversion are commonly done on the same site, and the scrap is used internally. Therefore, the "demand" or "consumption" of tissue converters is equal to their output.

In Table III-5 we have projected the domestic demand for the major functional groups through 1983. The expected increase to some 91 million tons is substantially lower than other published estimates,* which range up to 93-95 million tons. The more optimistic estimates were made before the onset of a severe worldwide recession, when few could anticipate the duration or extent of the falloff in economic activity. We expect the recession to have a profound impact upon the level of paper production that will be achieved by 1983.

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*See, for example, "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973 and "Fiber Requirements of the Paper Industry in the Seventies and Eighties," by Benjamin Slatin (API), paper presented at TAPPI Secondary Fiber Conference, San Francisco, Calif., September 15, 1971.

TABLE III-4

PRODUCTS INCLUDED IN FUNCTIONAL GROUPS

Functional Group	Paper Grade as Defined by API	1973 Production MM Tons		1973 Production % of Total	
1. Containerboard			19.39		31.4
	Unbleached Kraft Packaging & Industrial Converting Paperboard				
	Unbleached linerboard	12.98		21.0	
	Corrugating medium Folding carton type Other unbleached packaging & industrial converting kraft	0.58		0.9	
	Semi-Chemical Paperboard	4.32		7.0	
	Combination Paperboard-Shipping Containerboard				
	Linerboard Corrugating medium Container chip & filler	1.51		2.5	
2. Groundwood Paper			4.87		7.9
	Newsprint	3.41		5.5	
	Groundwood Paper, Uncoated				
	Publication & Printing Miscellaneous Groundwood	1.46		2.4	
3. Tissue and Other Machine Creped Paper			3.96		6.4
	Sanitary Paper				
	Toilet Tissue Facial Tissue Napkin Toweling	3.76		6.1	
	Tissue Paper, excl. Sanitary and Thin Tissue	0.20		0.3	
4. Folding Boxboard			7.67		12.4
	Bleached Packaging & Industrial Converting Paperboard*				
	Folding carton type Milk carton Heavyweight cup stock Plate, dish & tray Linerboard Other, incl. solid groundwood pulp board	3.92		6.3	
	Combination Paperboard - bending	2.76		4.5	
	Combination Paperboard - nonbending	0.99		1.6	
5. Printing, Writing and related			11.82		19.2
	Coated Printing & Converting Paper				
	Coated, one side Coated, two sides	3.85		6.3	
	Book Paper, uncoated				
	Publication & printing Body stock for coating Other converting & misc. book	3.06		5.0	
	Writing and Related				
	Cotton fiber Chemical wood pulp Cover & text Thin	3.78		6.1	
	Bleached Bristols				
	Tab, index & file folders Other uncoated Coated	1.13		1.8	

TABLE III-4 (Cont'd)

PRODUCTS INCLUDED IN FUNCTIONAL GROUPS

		1973 Production	
Functional Group	Paper Grade as Defined by API	MM Tons	% of Total
6. Industrial Packaging, Converting & Misc.		7.37	12.0
	Unbleached Kraft Packaging & Industrial Converting Paper		
	Wrapping	4.01	6.5
	Shipping sack		
	Bag & sack, other than shipping sack		
	Packaging & Industrial Converting Paper, except Unbleached Kraft		
	Wrapping	1.26	2.1
	Shipping sack		
	Bag & sack, other than shipping sack		
	Other Converting		
	Special industrial paper	0.56	0.9
	Tube, can & drum paperboard	1.54**	2.5
	Special (combination) packaging & converting		
7. Construction Paper		6.61	10.7
	Construction Paper	1.81	2.9
	Insulation Board	1.66	2.7
	Hard Pressed-Wood Fiberboard	2.09	3.4
	Gypsum Linerboard	1.05**	1.7
TOTAL 1973 PRODUCTION (less wet machine board)		61.69	100

* Excludes tube, can and drum paperboard

** Arthur D. Little, Inc., estimate

TABLE III-5

PROJECTED U.S. DEMAND FOR PAPER AND PAPERBOARD

Functional Group	1973 (MM tons)	Average Growth (%/Yr)	1977 (MM tons)	Average Growth (%/Yr)	1983 (MM tons)
Containerboard	17.7	3.0	20.0	3.8	25.0
Groundwood Paper	12.2	2.6	13.6	2.6	15.8
Tissue and Other Machine Creped Paper	4.0	3.0	4.5	2.5	5.2
Folding Boxboard	7.7	2.0	8.3	2.0	9.4
Printing, Writing and Related	11.9	3.5	13.6	3.5	16.8
Industrial Packaging, Converting and Miscellaneous	7.6	2.9	8.5	2.9	10.1
Construction Paper and Board	5.9	3.5	6.9	3.5	8.5
TOTALS	67.0	3.1	75.4	3.1	90.8

Sources: U.S. Department of Commerce (1973) and Arthur D. Little, Inc., projections

This table indicates that growth in the demand for paper and paperboard products will drop to about 3% per year compared with 4.5% in 1960-1970. This slower rate of growth, which will be experienced by all of the functional groups, will be caused by a number of factors:

(1) The 1973 base year used for the projection was above the demand trend-line for most functional groups and is being followed by two recessionary years, which lowers the growth rate between 1973 and 1977.

(2) We have assumed that the U.S. real GNP will grow at an average annual rate of 3.4% through 1983, compared with a growth of 3.9% per year in 1960-1970.

(3) The slower rate of growth in capacity that we expect in this industry will result in a generally tight supply/demand balance, which will cause relatively rapid price escalation and thus reduce demand from what it might have been if prices were lower and the supply were more abundant.

C. CONTAINERBOARD

1. Products Included

The containerboard functional group consists of all the paperboard materials used in the construction of corrugated shipping containers. These include linerboard made either from unbleached kraft pulp, waste paper, or a combination of both; corrugating medium made from a combination of semi-chemical pulp and waste paper or entirely from waste paper; container chip and filler board, which is made entirely from waste paper; and unbleached kraft paperboard, which is used in folding boxboard applications. The characteristics and end-use criteria for each of these products are described below.

Since it is the surface layer of the corrugated sandwich, the chief function of linerboard is to provide the strength characteristics required of a corrugated container, chiefly resistance to bursting and crushing. Standard physical requirements for corrugated containers in the United States are set forth in Section 3 of Rail Rule 41, which governs shipping containers for goods shipped by rail across state borders. Identical standards for containers used for goods shipped by truck are contained in Rule 222 of the National Motor Freight Classification. Rule 41 was established in an era when corrugated containers were beginning to replace wooden crates. Both Rule 41 and Rule 222 are continually being modified, since trucks are now the principal mode of transportation for many products shipped in corrugated containers and these containers have almost completely replaced wooden shipping crates. Table III-6 summarizes the key physical requirements.

TABLE III-6

CORRUGATED CONTAINER REQUIREMENTS FOR RAILROAD AND TRUCK SHIPMENT

Corrugating Medium Requirements: Min. Caliper = 0.009 in., Min. Wt. = 26 lb/1000 sq ft

Linerboard Requirements:

	Fibreboard Boxes[a]											Dbl-thickness Score Line Boxes[a]			
	Single Wall					Double Wall					Triple Wall	Single Wall		Double Wall	
Max. wt. of Box and Contents (lb)	20	40	65	90	120	65	90	120	140	160	275	225	300	225	300
Max. Inside Dimensions, Length + Width + Depth (in.)	40	60	75	90	100	75	90	100	110	120	120	60	60	60	60
Min. combined wt. of Facings[b] (lb/1000 sq ft.)	52	75	84	138	180	92	110	126	222	270	264	138	180	110	126
Min. Bursting Test of Combined Board (psi)	125	175	200	275	350	200	275	350	500	600	-	275	350	275	350
Min. Puncture Test of Combined Board (in.-oz/in. of tear)	-	-	-	-	-	-	-	-	-	-	1100	-	-	-	-

a. These terms are qualified in the source document

b. Including center facing of double- and triple-wall containers.

SOURCE: Fiber Box Handbook, Fibre Box Association, 1974.

Unbleached kraft linerboard produced in the United States (typically at a basis weight of 42 lb/1000 sq ft) fully provides the strength required to meet Rules 41 and 222. The pulp furnish for recycled linerboard usually consists entirely of recycled corrugated containers and container converting plant clippings. The short-fiber corrugating medium component of these containers (about 30% of the furnish) coupled with the fiber degradation which takes place in repulping, makes it necessary to increase the basis weight of recycled linerboard somewhat above 42 lb/1000 sq ft if this material must match the strength of the typical 42-pound kraft linerboard. Alternatively, dry-strength chemicals may be added to obtain equivalent strength at the same basis weight. (See Section VIII-C-1.)

The chief function of corrugating medium is to provide a low-cost material for the corrugated inner layer. Minimal tearing resistance and folding properties are required, since these properties are provided by the linerboard layers.

Semi-chemical corrugating medium is made from a high-yield, partially cooked pulp that employs a neutral sodium- or ammonia-base sulfite pulping liquor.

Recycled corrugating medium, as defined by the API, is fluting material containing more than 25% waste paper. In fact, most recycled corrugating medium is made entirely from waste paper of various grades, including waste news, old corrugated containers, and mixed waste paper. The most common basis weight for corrugating medium is 26 lb/1000 sq ft.

Container chip and filler board is used to form the partitions or to line the inside of a corrugated box. Chipboard is the major product in this category; it consists of paperboard that is lighter than 26 lb/1000 sq ft, employed either as single sheets or as the facing of corrugated materials used for interior packaging such as partitions, dividers, pads, and cushioning.

The only real competitive threat to corrugated containers has come from the use of heavy-gauge shrink plastic film. This film can be wrapped around a pallet of packages and then shrunk by the application of heat to hold the load securely. However, shrink film now competes only in limited applications. Little substitution of other products for corrugated containers has been achieved.

Although folding-carton-type kraft paperboard should properly be placed in the folding boxboard group, its use in folding cartons is relatively small; we have included it here in order to completely represent the unbleached kraft paperboard sector.

2. Industry Structure

Containerboard is the largest single product category in the U.S. paper industry. Demand for the products in this group is directly related to the shipping container requirements of the full spectrum of American industry; thus, it is strongly influenced by the national economic activity.

There are no significant imports of any of the containerboard materials. Large amounts of linerboard are exported, however. (Linerboard is the only product in this group that is exported in significant quantities.) Domestic kraft linerboard producers are in a favorable export position, because they have generally cheaper wood and larger, more efficient mills than competitive producers in Canada, Scandinavia, and Russia, the only other major producing regions. U.S. exporters ship from the Pacific Northwest to Asian and Latin American markets and from the South to the Latin American and Western European markets. The economics of manufacturing and shipping do not favor export of recycled linerboard, chipboard, or corrugating medium; thus, these products are not significant export items.

While about 70 U.S. companies produce linerboard, corrugating medium, or both, the 13 largest account for nearly 80% of the U.S. production capacity for these materials, as shown in Table III-7. All of these firms are vertically integrated from control of a significant portion of the woodlands that support their pulp mills to the production of linerboard and semi-chemical corrugating medium. All but one, Great Northern Nekoosa, is further integrated to the production of corrugated containers. Only four--Container Corporation, St. Regis, Inland Container, and Crown Zellerbach--produce linerboard or corrugating medium entirely from waste paper.

The major producers have made a large commitment to woodland ownership and pulp and paperboard mills, which gives them a vested interest in containerboard made from virgin wood pulp. Moreover, these companies have a substantial share of the U.S. corrugated container market by virtue of their forward integration to container converting. In the past, this combination of factors has inhibited the use of recycled fiber in the manufacture of containerboard. To the extent that the comparative economics favor the use of recycled fiber, we expect the larger producers to use it either as a partial substitute or 100% replacement for virgin fiber to achieve incremental additions to production.

Container chipboard is generally produced as a relatively small portion of the product mix of recycled paperboard mills. Thus, there are no clearly dominant factors in the production of this material. Although it is made from 100% waste paper, it has a low growth rate because of the trend toward eliminating partitions and inner liners in corrugated containers.

In terms of geographical distribution, about 85% of U.S. kraft linerboard production is in the South and the remainder is in the West. Production of semi-chemical corrugating medium is distributed roughly 60% in the Northeast and North Central regions, 35% in the South, and 5% in the West, in approximate relationship to the distribution of the hardwood timber used for this product. Recycled corrugating medium, linerboard, and chipboard production is located close to the major population centers.

TABLE III-7

MAJOR CONTAINERBOARD PRODUCERS

Company	1973 Linerboard and Corrugating Medium Capacity	
	(Tons/Day)	(% of U.S. Capacity)
International Paper	5,605	9.9
Container Corporation	5,105	9.0
Weyerhaeuser	4,400	7.8
St. Regis	3,940	7.0
Westvaco	3,435	6.1
Union Camp	3,100	5.5
Owens-Illinois	2,970	5.3
Mead	2,890	5.1
Inland Container	2,540	4.5
Crown Zellerbach	2,440	4.3
Continental Can	2,410	4.3
Great Northern-Nekoosa	2,100	3.7
Hoerner-Waldorf	1,625	2.9
Total	42,560	75.4

Source: Lockwood's Directory of the Paper and Allied Trades, 1974

On balance, there is a net flow of linerboard from the South to the North Central and Northeastern regions and from the West to the North Central region. Each region is essentially self-sufficient in its combined production of semi-chemical and recycled corrugated medium and chipboard.

3. Supply/Demand Trends

Table III-8 compared our projections of containerboard demand with producers' expectations of capacity expansion through 1977. This indicates that unbleached kraft paperboard (mainly linerboard) was in extremely tight supply in 1973 and should be in equally tight supply as the economy fully recovers from the current recession (which we assume will occur by 1976). The capacity for recycled linerboard is expected to grow rapidly from a very small base, and its producers should continue to enjoy relatively high operating rates through 1977, in light of the tight supply which we foresee for kraft linerboard. If it were not for the capacity constraint in unbleached kraft paperboard, exports of kraft linerboard would probably grow at a higher rate than we have projected, since there has been a similar slowdown in linerboard capacity expansion throughout the world.

Corrugating medium was in tight supply in 1973, but it is now in oversupply due to the recession. Since announced capacity expansions indicate a rate of growth significantly higher than our demand projections, the oversupply is likely to continue through 1977. Beyond 1977 we expect that demand will exceed installed capacity. We believe that a large part of this additional demand will be met by the manufacture of recycled medium.

However, it is possible for some producers of semi-chemical corrugating medium to make linerboard on their machines; similarly, those who make recycled corrugating medium can shift to linerboard or folding boxboard. Such shifts in product mix may entail some economic sacrifice, but perhaps not as much as if the producers continued to make only corrugating medium at a low operating rate.

Container chipboard was in plentiful supply in 1973 and should remain so through 1977. This product is generally made on relatively old, slow cylinder machines; economical production does not require as high an operating rate as does linerboard or corrugating medium. Here again, producers could shift to other recycled paperboard products; this contributed to a relatively tight supply condition in 1973 and should help to alleviate the low operating rate projected for 1977.

4. Market Characteristics

a. Selling Prices

Containerboard material prices are highly sensitive to the supply/demand ratio. Table III-9 shows the price increases which have occurred between

TABLE III-8

CONTAINERBOARD SUPPLY/DEMAND TRENDS

	Preliminary 1973 (000 tons)		Average Growth (%/Year)		Projected 1977 (000 tons)	
UNBLEACHED KRAFT PAPERBOARD[a]						
Production		13,560		3.0		15,300
Linerboard	11,340		3.0		12,680	
Other Unbl. Kraft Board	574		2.8		640	
Exports (Linerboard)	1,646		4.7		1,980	
Capacity		13,898		3.0		15,623
Apparent Operating Rate	98%				99%	
RECYCLED LINERBOARD						
Production		284		18.0		550
Capacity		306		18.9		612
Apparent Operating Rate	93%				90%	
CORRUGATING MEDIUM						
Production		5,303		3.0		5,915
Semi-Chemical	4,302				4,600	
Recycled	981				1,290	
Export	20				25	
Capacity		5,564		6.1		7,050
Semi-Chemical	4,386		4.3		5,187	
Recycled	1,178		12.1		1,863	
Apparent Operating Rate	95%				85%	
CONTAINER CHIPBOARD						
Demand		247		3.0		280
Capacity		349		5.4		430
Apparent Operating Rate	71%				54%	

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[a] Excludes tube, can, and drum paperboard

SOURCE: Capacity - American Paper Institute
Demand - U.S. Department of Commerce (1973)
1977 Projections - Arthur D. Little, Inc.

1971, when operating rates were relatively low (85-90% of capacity), and 1974, when operating rates were extremely tight (about 95-99% of capacity, a practical maximum) for a full year.

TABLE III-9

CONTAINERBOARD PRICE TRENDS
(Fourth-quarter contract prices, $/ton)

Product	1971	1972	1973	1974
Unbleached Kraft Linerboard	120	130	145	195
Recycled Linerboard	100	120	135	190
Semi-Chemical Corr. Med.	104	120	140	190
Recycled Corr. Med.	100	120	135	190
Container Chip and Filler	100	120	135	190

Source: Paper industry contacts

The price increases since 1971 are unprecedented in the industry since World War II. They reflected not only a tightening supply situation but accumulated cost inflation since 1969, which the producers had been unable to pass on because of low operating rates.

Since linerboard operating rates are expected to remain relatively high over the next several years, the price of this material should continue to increase rapidly after the current recession. Corrugating medium and chipboard prices probably will not rise as rapidly by 1977, in view of the projected overcapacity for these materials.

b. Profitability

As is typical of other product sectors in the paper industry, there are no publicly-held companies that produce only containerboard materials. Therefore, we can only discuss subjectively current product-line profitability based on prices and operating rate trends.

We estimate that the profitability of kraft linerboard is above the paper industry average and that semi-chemical corrugating profitability is close to average. Profitability is probably below the industry average in the recycled paperboard sector. Except for linerboard, profitability varies widely among mills in these sectors, due to variations in mill sizes and other site-related factors.

Profitability in all containerboard sectors has improved considerably since 1971, when low operating rates and weak prices prevailed. We expect that profit margins will continue to improve, particularly for kraft linerboard, in response to the protracted tight supply conditions foreseen through 1977. Semi-chemical and recycled corrugating medium are two of the few products whose production will probably decline through 1977; hence, the spread in profit margins between these products and kraft linerboard is likely to widen over the next several years.

5. Factors Affecting Increased Utilization of Waste Paper

Several important factors affect the potential utilization of waste paper in linerboard. First, the kraft linerboard producers who dominate the market have a vested interest in the large-scale pulp and paperboard mills that are integrated to their pulpwood supplies and operations in the South and Pacific Northwest. Also, since mill locations have been determined by pulpwood accessibility, they do not necessarily have access to an economical supply of waste corrugated containers. On the other hand, pulp mill expansion involves large capital costs, pulpwood costs are rising rapidly, and the extension of woodland ownership is also costly; therefore, if producers are able to obtain an economical supply of waste paper, they are likely to look favorably upon supplementing their virgin pulp furnish with OCC and thereby expand their capacity incrementally.

Another factor that influences the likelihood of waste paper use is the high degree of forward integration in this sector. Integration from linerboard production through box converting limits the independent growth of board production. Despite the high consumption of linerboard, independent markets are limited. This has placed an additional constraint on the growth of 100% recycled linerboard by independent producers.

Waste paper prices have historically shown wide fluctuations. This has placed a constraint on production of 100% recycled linerboard by making financial performance unpredictable. Some believe that the railroad and trucking rules on corrugated containers call for an overdesigned package; it is far superior to the shipping containers used in Western Europe, for example. There may be some opportunity for reducing product strength requirements, thus creating an attractive market for 100% recycled linerboard. As softwood pulpwood costs and linerboard prices continue to increase, there should be greater incentive to increase recycled linerboard capacity if waste corrugated container prices can be stabilized and held to a lower rate of growth than virgin pulp costs.

A substantial amount of waste paper is already used in corrugating medium, both semi-chemical and 100% recycled. The biggest obstacle to its increased use is the abundant supply of hardwood timber for semi-chemical corrugating medium in the North Central, Northeastern, and Southern states. Because of this, a substantial increase in the use of recycled corrugating medium will require that the costs of hardwood pulpwood rise faster than those of OCC and kraft clippings.

As the costs of controlling air and water pollution increase, and as semi-chemical pulping facilities face shutdown unless they are equipped with chemical recovery systems, there is a greater incentive to use more waste paper in both linerboard and corrugating medium.

D. GROUNDWOOD PAPERS

1. Products Included

The products in this category utilize a substantial amount (usually greater than 50%) of mechanically ground wood pulp in their fiber furnish. Groundwood-content papers are utilized in printing applications that do not require archival properties, because they will discolor when exposed to ultraviolet light. Thus, groundwood papers are used for products such as newspapers, telephone directories, some mail-order catalogues, and other printed articles that are generally discarded within one year. This category includes newsprint, uncoated groundwood paper, uncoated book paper, and groundwood-content stock for coated printing paper.

Newsprint is by far the largest of the two grades, with a total U.S. consumption of nearly 11 million tons in 1973. It is generally made from a pulp furnish consisting of about 80% unbleached groundwood and 20% unbleached sulfite or semi-bleached kraft pulp. (Groundwood pulp from the West Coast is often lightly bleached.) Using thermo-mechanical pulping, some producers have been able to reduce the chemical pulp content of their newsprint furnish to below 20%. Three U.S. newsprint mills produce newsprint entirely from waste newspapers.

Most newsprint is sold direct to the daily newspaper publishers and the multiple-newspaper printing plants. A small portion (less than 5%) is distributed via paper merchants to small users such as small weekly newspaper publishers, shopping newspaper publishers, and general commercial printers.

Uncoated groundwood paper is generally made from a furnish consisting of 20-50% of bleached chemical pulp and 50-80% of bleached groundwood pulp. Its principal applications are for telephone directories, catalogues, paperback books, low-priced magazines, comic books, and general commercial printing. Most of this product is distributed directly to the large end-users, such as catalogue and directory publishers and the large paperback book publishers; however, a substantial amount (probably more than 25%) is distributed through paper merchants to small users, such as the smaller magazine publishers and general commercial printers.

2. Industry Structure

Canadian newsprint mills play a pivotal role in supplying U.S. needs and hence must be included in the industry's structure. In 1973, Canadian mills supplied about 69% of the U.S. demand for newsprint, and U.S. mills supplied the remaining 31%. Table III-10 lists the capacities of the major North American newsprint suppliers.

Table III-10 indicates that the recent acquisition of the Price Company by Abitibi Paper Company has given it a dominant share of North American capacity; Abitibi-Price operates two mills in the United States and six in Canada. Until this merger, International Paper Company had the largest share of the North American market. Southland Paper Mills has the largest U.S. capacity and is a dominant factor in the market region around southeastern Texas. Garden State Paper and FSC Paper Corp., in which Garden State has an interest, currently operates the only three U.S. mills that make newsprint from 100% waste newspapers; these mills represent only 2.6% of North American capacity but 10% of U.S. newsprint capacity.

The newsprint market is relatively concentrated. The top 14 firms in North America have nearly an 80% share of total North American capacity and about an equal share of the North American market. Most of the Canadian producers have substantial exports outside of North America, particularly to Europe and South America. International trade in newsprint is facilitated by the fact that most countries have little or no import duties on this product.

Table III-11 lists capacities of the U.S. uncoated groundwood paper producers. Imports of groundwood paper from Canada or elsewhere are not significant (126,000 tons in 1973); the import duty, coupled with the freight advantage enjoyed by U.S. producers, make it difficult for exporters to compete.

Traditionally, the uncoated groundwood paper market has been viewed as a specialty application for newsprint machines that are no longer competitive in the newsprint market. This is the route of entry used by all current suppliers. Recently, however, Great Northern-Nekoosa and Fraser Paper have installed new machines to supply this market and to increase their market share. These two companies, along with International Paper, are the major U.S. producers.

All of the newsprint producers and all but a few of the smaller uncoated groundwood paper producers control (via ownership or lease) at least a portion of the woodlands needed to supply their mills and are vertically integrated to the production of groundwood and often chemical pulp, paper production, and the marketing of the final product. Garden State and FSC Paper operate their own waste paper collection organizations, which supply a portion of their raw material requirements.

3. Supply/Demand Trends

Table III-12 shows projections of U.S. supply/demand trends for newsprint and uncoated groundwood papers through 1977. Both products had extremely

TABLE III-10

CAPACITIES OF MAJOR NORTH AMERICAN NEWSPRINT SUPPLIERS, 1974

Company	Capacity (000 tons/yr) U.S.A.	Canada	Total	Percent of North American Capacity
Abitibi-Price	235	2,179	2,414	17.0
International Paper	243	1,156	1,399	9.9
MacMillan-Bloedel		1,380	1,380	9.7
Consolidated Bathurst		1,043	1,043	7.4
Bowaters	437	603	1,040	7.4
Ontario Paper		731	731	5.2
Kimberly-Clark	420	174	594	4.2
Boise Cascade	212	317	529	3.7
Southland Paper Mills	474		474	3.3
Crown Zellerbach	217	256	473	3.3
Great Lakes Paper		439	439	3.1
Garden State & FSC Paper	372		372	2.6
Great Northern - Nekoosa	360		360	2.5
Publishers Paper	360		360	2.5
Total				78.5

Source: "Newsprint Statistics", American Newspaper Publishers Assn. April 12, 1974

TABLE III-11

CAPACITIES OF U.S. UNCOATED GROUNDWOOD PAPER SUPPLIERS, 1973

Company	Capacity (000 tons/yr)	Percent of U.S. Capacity
International Paper	235	16.7
Great Northern-Nekoosa	225	16.0
Fraser Paper	175	12.4
Boise Cascade	161	11.5
Appleton Papers	140	10.0
St. Regis Paper	116	8.3
Manistique Pulp and Paper	35	2.5
Inland Empire	35	2.5
Hennepin	28	2.0
Mountain Paper Products	8	0.6
Unidentified and Other	245	17.5
Total	1403	100.0

Source: Lockwood's Directory of the Paper and Allied Trades, 1974.

TABLE III-12

GROUNDWOOD PAPER SUPPLY/DEMAND TRENDS

	Preliminary 1973 (000 tons)	Average Growth (%/yr)	Projected 1977 (000 tons)
NEWSPRINT			
U.S. Demand[a]	10,726	2.6	11,900[b]
Less: Net Imports	7,313	2.4	8,100[b]
Demand for U.S. Production	3,413	2.7	3,800[b]
Capacity	3,597	2.2	3,925[b]
Apparent Operating Rate	95%		97%
UNCOATED GROUNDWOOD PAPERS			
Demand	1,560	2.2	1,700
Less: Net Imports	99	19.2	200
Demand for U.S. Production	1,461	0.7	1,500
Capacity	1,403	1.0	1,462
Apparent Operating Rate	104%		103%

[a] U.S. consumption of newsprint in 1973 was reported as 10,504,000 tons by the American Newspaper Publishers Association ("Newsprint Statistics," April 1974)

[b] Tonnage figures are based on 31.5 pound/ream newsprint; data should be reduced by about 5% to reflect 30 pound/ream newsprint, which is now the predominant basis weight.

SOURCE: Capacity - American Paper Institute; Demand - U.S. Department of Commerce (1973) and Arthur D. Little, Inc. projections.

high operating rates in 1973. (A 95-97% average operating rate is considered maximum capacity for newsprint mills over a full year.) The 104% apparent operating rate for uncoated groundwood paper suggests that some was made on newsprint machines in that year. In part, the tight supply of newsprint in 1973 was caused by newsprint-mill and railroad strikes in Canada, particularly during the third quarter.

Our projections of U.S. demand and net imports of newsprint and uncoated groundwood papers indicate that, in light of the capacity expansion plans reported by the American Paper Institute, a tight supply situation will again be reestablished by 1977 as the economy recovers from the current recession. We have also examined the capacity expansion plans for the Canadian producers, as reported by the Canadian Pulp and Paper Association; these indicate that the Canadian producers will be hard pressed to supply the requirements of the United States, their principal regional market, through 1977. To stretch the available fiber resources and thereby facilitate incremental expansion of existing mills, newsprint producers began reducing basis weights in 1974 from the historical 32 pounds to 30 pounds, and some are now making 28-pound paper. This trend has also helped newspaper publishers to hold down their costs somewhat.

While the markets for newsprint and uncoated groundwood paper are extremely mature, demand is currently being bolstered by the fact that the price differential between the groundwood-free printing papers and the groundwood papers has widened appreciably over the past year with the rapid increase in bleached pulp prices. For example, there is currently a $205/ton differential between No. 3 offset uncoated book and catalog-grade groundwood paper; a $275/ton differential exists between uncoated book and 30-pound newsprint. In January 1974, the differentials were about $100 and $115 respectively. Thus, newsprint and uncoated groundwood paper have become more price competitive with the groundwood-free papers and are finding greater use in printing applications where long-range storage of the paper is not required. One such relatively new application for groundwood paper is in business forms, where approximately 100,000 tons of groundwood paper was substituted for the traditional register bond in 1974.

4. Market Characteristics

a. Price Trends

Because of the substantial world trade in newsprint, selling prices for this product respond directly to shifts in the world supply/demand balance expressed as a composite operating rate of producers. As a result, when the world supply tightened in mid-1973 and 1974, newsprint prices rose rapidly to their present levels.

Table III-13 shows the rapid sequence of price increases that took place as industry operating rates approached maximum levels in 1973 and

TABLE III-13

NEWSPRINT CONTRACT PRICE TRENDS, 1970-1975

	Eastern U.S.		Western U.S.	
	$/Ton	Effective	$/Ton	Effective
1970	152	Jan. 1	147	Jan 1
1971	160	April 1	155	Jan. 1
1972	165	Feb. 1	163	Jan. 1
1973	175	Mid Year	173-200[a]	Sept.-Dec.
	200[a]	Nov. 1		
1974[b]	200 (213)	March 1	200 (213)	March 1
	220 (235)	Aug. 1	230 (245)	Aug. 1
1975[b]	244 (260)	Jan. 1	262 (280)	

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[a] Canadian-produced newsprint, free of U.S. price controls.

[b] Figures in parentheses reflect prices for 30-lb newsprint, which became the industry standard in 1974.

SOURCES: American Newsprint Publishers Association and industry contacts.

particularly after U.S. price controls were fully lifted in June 1974. Western producers, who traditionally sold newsprint at a discount below Eastern prices, instituted a price premium in 1974; this was made possible both by the tight market conditions and the fact that only a few producers dominate the Western market.

Table III-14 shows a similar trend of price escalation in uncoated groundwood paper, as typified by the catalog grade. As we shall see later, prices of groundwood-free printing and writing papers increased even more rapidly than the uncoated groundwood grades; this indicates that the prices of the uncoated groundwood grades are more closely patterned after that of newsprint, to which they are more closely related. The resulting wider price differential between the groundwood-free grades and uncoated groundwood papers makes the latter more price competitive and should stimulate their demand. However, the extremely tight supply situation foreseen through 1977 indicates that the demand for the uncoated groundwood grades will not be completely filled; thus prices will continue to escalate, possibly narrowing the gap with the groundwood-free grades.

b. Profitability

We estimate that the current profitability for newsprint production is currently close to the average for the overall paper and allied products industry. Profitability for uncoated groundwood paper is highly variable, because of the wide range of company sizes and the fact that both integrated and nonintegrated producers participate in this sector. We believe that Great Northern-Nekoosa is the industry leader from the standpoint of profitability and that it earns a better return on its uncoated groundwood papers than the average paper industry profitability. On the other hand, some of the smaller producers appear to be making only marginal profits at present.

5. Factors Affecting Increased Waste Paper Utilization

Three U.S. mills are currently producing newsprint from 100% waste newspapers in the vicinity of New York, Chicago, and Los Angeles. These mills account for about 10% of U.S. newsprint capacity but only 2.6% of North American capacity. All three have been successful in penetrating the market; however, forward integration of the industry from newsprint production through newspaper publications restricts the volume of newsprint that they can market independently.

The use of waste news as a supplement to virgin fiber in the manufacture of newsprint is a new and, we believe, significant growth opportunity for recycled fiber. (See Section VIII-D.)

TABLE III-14

UNCOATED GROUNDWOOD PAPER PRICE TRENDS, 1971-1974

Year	Price ($/ton)
1971 Year End	190
1972 Year End	195
1973 Year End	237
1974 - January	247
March	262
April	270
July	300
October	320

Sources: H.C. Wainwright & Company surveys of producers and industry contacts

E. TISSUE AND OTHER MACHINE CREPED PAPER

1. Products Included

The tissue sector primarily includes sanitary grades (toilet, facial, napkin, toweling, sanitary napkin, wiper, and special sanitary papers) that are sold both to the consumer and industrial markets. Table III-15 shows U.S. shipments of tissue by type in 1973.

The channel of distribution for consumer sanitary tissue is usually via direct sales from the paper converter to grocery stores or chain stores, either under a brand name or under the private label of the chain store. Industrial sanitary tissue is typically distributed through paper merchants or industrial maintenance supply houses.

The tissue sector also includes nonsanitary tissue papers, such as waxing tissue, wrapping tissue, cellulose wadding, and miscellaneous products. Most waxing tissue is waxed and converted by the paper manufacturer, who then sells it to commercial distributors to reach the fast-food and institutional markets or sells it directly to the chain stores to reach the consumer market. Wrapping tissue and industrial cellulose wadding are usually sold through paper merchants or jobbers.

All of the above grades are usually made from a combination of various bleached pulps, including sulfite and kraft (both softwood and hardwood), groundwood, and deinked or high-grade waste paper. A limited amount of 100% deinked waste paper is used for sanitary tissue products.

Thin papers, such as carbonizing tissue and condenser tissue, are not included in the tissue paper sector but rather in the printing, writing, and related papers sector.

2. Industry Structure

Table III-16 shows the 1973 capacities of the major U.S. tissue producers. Procter & Gamble and Scott Paper are the leading tissue producers, with about an equal share of U.S. capacity. Both these companies and Kimberly-Clark have national market coverage for the consumer sanitary tissue products in which they specialize, and all advertise their brand-name products on national network television. American Can has nearly national market coverage except in the Northeast. The remaining large suppliers of consumer sanitary tissue (Georgia-Pacific, Crown Zellerbach, Brown Company, and Hudson Pulp and Paper) sell in selected market regions.

Nearly all of the above companies sell some of their sanitary tissue to the industrial market, but the major factor in this market is Fort Howard Paper Company. In total, the above nine firms account for about 88% of the total U.S. tissue capacity.

TABLE III-15

U.S. TISSUE SHIPMENTS BY PRODUCT TYPE, 1973

Product Type	Preliminary 1973 Shipments (000 tons)		% of Total Tissue
Sanitary Tissue Papers			
Toilet Tissue	1,412		35.4
Facial Tissue	362		9.1
Napkins	440		11.1
Towels	1,279		32.1
Wipers	61		1.5
Other	181		4.6
Sub-Total		3,735	93.8
Nonsanitary Tissue Papers			
Waxing Tissue	51		1.3
Wrapping Tissue	70		1.7
Industrial Cellulose	36		0.9
Miscellaneous Tissue	91		2.3
Sub-Total		248	6.2
TOTAL		3,984	

SOURCE: American Paper Institute, "Statistics of Paper and Paperboard," 1974.

TABLE III-16

CAPACITIES OF MAJOR U.S. TISSUE PRODUCERS, 1973

Producer	Capacity (000 tons/yr)	% of Total U.S. Capacity
Procter & Gamble	1,075[a]	25
Scott Paper	1,000	23
American Can	405	9
Kimberly-Clark	400	9
Fort Howard Paper	280	6.5
Georgia-Pacific	215	5
Crown Zellerbach	200	3
Brown Company	110	3
Hudson Pulp & Paper	105	2
	TOTAL	87.5%

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[a] Arthur D. Little, Inc., estimate

SOURCE: Lockwood's Directory of the Paper and Allied Trades, 1974

All of the above firms are integrated at least partially to the production of bleached chemical wood pulp; American Can, Kimberly-Clark, and Georgia-Pacific also operate waste paper deinking facilities.

About 45 other companies also operate tissue mills in the United States. Most of them are not integrated to chemical pulp production but rely instead on purchased market pulp for their raw material. A number of these firms also operate waste paper deinking facilities to provide a portion of their fiber requirements. All of these firms tend to concentrate their marketing on private-label consumer tissue, industrial sanitary tissue, and nonsanitary tissue. Thus, they avoid the heavy marketing expenses associated with brand-name advertising in the consumer tissue market.

There are virtually no imports of tissue paper products, and exports are very minor (less than 1% of U.S. production). Thus, foreign suppliers or customers are not a factor in the U.S. tissue paper market structure.

Tissue paper production tends to be located relatively close to the major population centers because of the high cost of shipping the relatively bulky sanitary tissue products. The West North Central region is the only area that does not have tissue capacity. The largest regional concentration of tissue paper mills is [illegible] the East North Central region, which accounts for about 25% of U.S. capacity and is a net exporter to the West North Central and other surrounding regions. Other major importing areas are the South Atlantic, West South Central, and Mountain regions. Appendix A-1 includes a breakdown of tissue paper capacity by state and region.

3. Supply/Demand Trends

Table III-17 shows our projection of the operating rate in the tissue paper sector through 1977. The operating rate is likely to be very high in 1977 because of slow capacity expansion and an assumed recovery from the current recession by 1976. In this sector of the industry, an average 95% operating rate over a full year is a practical maximum.

Our demand projections might be optimistic, in light of the current recession, the rapid price increase for tissue products, and the slowing of population growth. However, even if the sanitary tissue sector were to grow only 2% annually, the tissue industry operating rate would average around 92% of capacity in 1977, which is still a relatively high operating rate.

Both the sanitary and nonsanitary tissue product categories have reached nearly full maturity and are now growing at only slightly above the population growth rate. In the 1950's and the 1960's, sanitary tissue demand grew an average of 5% per year; at that time, it was still displacing cloth products, particularly in the napkin, towel, and facial tissue product areas. There are no cheaper substitutes for sanitary tissue

TABLE III-17

TISSUE PAPER SUPPLY/DEMAND TRENDS, 1973-1977

	Preliminary 1973 (000 tons)	Average Growth (%/Year)	Projected 1977 (000 tons)
Demand for U.S. Production			
Sanitary Tissue	3,735	3	4,200
Non-Sanitary Tissue	248	2	270
Total Demand	3,983	2.9	4,470
Capacity	4,303	2.2	4,697
Apparent Operating Rate	93%		95%

SOURCE: American Paper Institute (1973 shipments and capacity data) and Arthur D. Little, Inc., demand projections products, but rising prices are likely to cause consumers to economize on their use; i.e., there is some elasticity to the demand. However, demand for industrial sanitary tissue products is likely to be less price-elastic.

In the nonsanitary tissue area, waxing tissue is being displaced by plastic films and foil packaging materials. However, consumption of wax paper has already declined to such an extent that the substitution trend has probably nearly run its course. The growth of wrapping tissue and industrial cellulose wadding is likely to parallel industrial production.

4. Market Characteristics

a. Selling Prices

Most of the tissue paper producers have on-site converting facilities; very little tissue paper is sold in the form of jumbo rolls. Therefore, price trends are best measured on the basis of converted product prices. This, however, poses a problem in that there is a wide variety of converted products with significant brand-name and quality differentiations. To illustrate price trends, we have employed the Bureau of Labor Statistics Wholesale Price Indexes for the converted sanitary paper group as a whole (Table III-18).

Like most other paper products, tissue paper experienced relatively little upward price movement until late 1973. At that time, a tight supply/demand balance, coupled with rising costs of pulp and other materials and labor, caused the producers to establish higher prices. Between November 1973 and October 1974, sanitary tissue prices increased by 30%. We understand that prices of nonsanitary tissue rose by about the same amount. Prices of products that utilized a large proportion of deinked waste paper in their fiber furnish generally remained somewhat below those of products made largely of chemical wood pulp fiber; this reflects a somewhat lower consumer acceptance of tissue made from waste paper, apparently because of its slightly off-white color.

b. Profitability

Since none of the publicly owned tissue companies produce tissue paper alone, it is difficult to develop composite data on tissue-sector profitability. We believe, however, that the biggest producers--Procter & Gamble, Scott Paper, American Can, Kimberly-Clark, and possibly Fort Howard Paper--are achieving a level of profitability in their tissue business that is above average for the paper and allied products industry. Profits of the other major tissue producers are probably about in line with the industry average, and the smaller producers are below average.

We understand that many of the tissue paper producers that are not integrated to pulp are achieving only marginal profits at present, because the price of the market pulp they use has increased much more rapidly than they have been able to raise tissue paper prices. Although con-

TABLE III-18

WHOLESALE PRICE INDEX FOR CONVERTED SANITARY TISSUE
(Index 1967=100)

Year		Index
1965	Average	92.2
1966	Average	95.0
1967	Average	100.0
1968	Average	104.2
1969	Average	109.1
1970	Average	115.1
1971	Average	119.5
1972	Average	121.0
1973	Average	124.8
	November	127.2
1974	January	130.6
	March	134.3
	April	139.8
	August	149.8
	October	165.4

SOURCES: Bureau of Labor Statistics (1965-1973), Wholesale Prices and Price Indexes, U.S. Department of Labor; Arthur D. Little, Inc., computations for November 1973-October 1974, based on H.C. Wainwright and Company industry price surveys.

tinued high operating rates are likely to increase the profitability of the integrated producers by 1977, it is questionable whether the nonintegrated producers will participate in this trend, since market pulp prices will probably continue to increase at a more rapid rate than tissue paper prices.

5. Factors Affecting Increased Waste Paper Utilization

In 1973, about 1.2 million tons of waste paper (about 30% of total fiber furnish) was used in making tissue paper. Most of it was combined with bleached chemical pulp, although a significant amount went into 100% waste paper products. The biggest opportunity for increased waste paper consumption in this sector probably lies in using a larger proportion in the pulp blends. Tissue producers should be encouraged to engineer their products for each application by taking advantage of the strength and brightness of the virgin chemical pulps and the absorbency and bulk of secondary fibers.

One factor that will stimulate the use of waste paper in the tissue paper sector is the projected rapid price increase for bleached market pulp. Higher pulp prices will increase the demand for the pulp-substitute and high-quality deinking grades typically used in tissue manufacture. Old news is an alternative source of recycled fiber for this application; however, we do not expect a major change in the tissue fiber furnish to include significant amounts of groundwood fiber. (See Sections VIII-E and X-C.)

The companies with the greatest incentive to shift to secondary fiber are those that are not integrated to chemical pulp. However, these are usually the least profitable smaller firms, many of which do not have sufficient capitalization or profitability to enable them to invest in deinking facilities. Another consideration is that many of the existing mills may not be able to build deinking facilities because they cannot cope with any added water pollution loadings at their present sites.

F. FOLDING BOXBOARD

1. Products Included

Table III-19 lists the major products which we have included in the folding boxboard category. These include bleached paperboard or SBS (solid bleached sulfate), bending combination (recycled) paperboard, and nonbending combination paperboard. The table also shows that almost 30% of the bleached paperboard is used in a variety of applications other than folding cartons, and we have included these to maintain full coverage of the bleached paperboard grade category.

Similarly, even though nonbending combination paperboard is primarily used to make set-up boxes, we have included it in the table because

TABLE III-19

U.S. PRODUCTION OF BLEACHED AND WASTEPAPER BOXBOARD BY TYPE, 1973

Boxboard Type	Preliminary 1973 Production (000 tons)	Percent of Total Boxboard
Bleached Paperboard		
Folding Carton Type	1,755	22.7
Milk Carton	1,069	13.9
Heavyweight Cup Stock	414	5.4
Plate, Dish and Tray	340	4.4
Linerboard	182	2.4
Other	204	2.5
Subtotal	3,966	51.4
Combination Paperboard, Bending	2,763	35.8
Combination Paperboard, Nonbending	991	12.8
TOTAL	7,720	100.0

SOURCE: U.S. Department of Commerce, Bureau of the Census, Pulp, Paper and Paperboard, Series M26A.

these boxes compete with folding cartons in certain applications and because paperboard manufacturers often produce both the bending and nonbending types in the same mill.

Bleached paperboard is made from a combination of hardwood and softwood pulp fibers made by the sulfate or kraft process. Most of this board is coated with clay pigment and/or polyethylene film to improve its printing characteristics and/or barrier properties.

Combination paperboard is generally made from 100% waste paper fiber furnish. The bending type is usually pigment-coated or lined with deinked pulp to enhance its appearance and printing characteristics. The nonbending type, which is heavier and stiffer than folding boxboard, is seldom coated or made with a white liner but often has a coated paper outer liner; its principal applications are set-up boxes for shoe boxes, department store boxes, and hardware boxes.

Bending combination board competes directly with folding-carton-type SBS. The SBS dominates in food applications (e.g., frozen food, ice cream, and sugar.) Recycled paperboard is used in most food packages that have an inner lining, such as those for dry cereals and crackers, and in unlined packages for such dry foods as rice and macaroni. In nonfood applications, SBS tends to be used for high-margin products such as drugs and cosmetics because of its esthetic appearance. (See Section VIII-F.)

SBS must compete with plastics in a number of applications. Frozen food cartons are being gradually displaced by plastic bags. Milk cartons and paper cups, trays, and plates are facing significant competition from plastic blow-molded milk containers and from thermoformed plastic cups, trays, and plates.

Plastics are having less effect on the demand for recycled paperboard folding cartons, although they often are used in conjunction with recycled paperboard in such applications as bubble packaging of hardware parts mounted on a printed piece of paperboard.

2. Industry Structure

Table III-20 lists the major U.S. producers of bleached boxboard and their current share of U.S. capacity for this product. It can be seen that this sector of the paper industry has a relatively few large producers, and is therefore quite concentrated. One reason for this is that the minimum economic scale of operations is quite large (about 800 tons/day*) ; hence a large amount of capital is required to gain entry by building a new mill.

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*The approximate output of two large board machines

TABLE III-20

MAJOR U.S. BLEACHED BOXBOARD PRODUCERS

Producer	1973 Capacity (000 tons/yr)	Percent Total U.S. Capacity
International Paper	720	18.3
Westvaco	360	9.2
Potlatch Forests	245	6.2
Continental Can	240	6.1
Eastex	225	5.7
Weyerhaeuser	220	5.6
Champion International	220	5.6
Federal Paperboard	215	5.5
American Can	190	4.8
Gulf States	170	4.3
Container Corp.	168	4.3
Subtotal	2,973	75.7
Other	955	24.3
TOTAL	3,928	100.0

SOURCE: Lockwood's Directory of the Paper and Allied Trades, 1974.

All the producers of bleached paperboard are integrated to on-site pulp production. All are also integrated to some degree forward to the production of folding cartons, milk cartons, or other end products. Most bleached paperboard mills are located in the South, although several are situated in the Pacific Northwest.

Table III-21 lists the major U.S. producers of recycled boxboard and their 1973 capacities. This sector is much more fragmented than the bleached paperboard sector. Only two producers have capacities greater than 10% of the U.S. total, and there are at least 45 producers of folding or set-up boxboard. Federal Paper Board Co., Fibreboard Corp., and Container Corporation of America are key producers and make both recycled boxboard and bleached paperboard for folding cartons.

Most producers of recycled boxboard are self-sufficient in their fiber requirements since they rely upon on-site repulping of waste paper as their principal source of fiber. In recent years, some of the smaller producers purchased market pulp to form the top liner, but all the major producers stopped this practice over ten years ago. Because of its high cost, we doubt that any recycled board producers still use market pulp. All of the recycled boxboard mills are located near major population centers in order to obtain the required supply of waste paper raw material and to be near the major folding carton and set-up box converting plants. Most of the recycled boxboard producers are integrated forward to some degree to the production of folding cartons and/or set-up boxes.

Imports of both bleached paperboard and recycled boxboard are insignificant or nonexistent. There are no significant exports of recycled boxboard, since the waste paper furnish is available in all industrialized regions; however, there are some exports of bleached paperboard (about 7% of 1973 production) to markets where U.S. producers are competitive by virtue of their large-scale mills and relatively low wood costs.

Figure III-4 shows recent trends in the production of SBS and recycled paperboard. It can be seen that not only has recycled (combination) board lost market share to SBS, but production has actually declined since 1966. Our market projection through 1977 indicates no sharp change in the respective role of these two products.

Table III-22 quantifies the share of recycled paperboard in specific market areas. It indicates the major role of recycled board in all categories except "wet" food packaging and perishable bakery applications. (This table was issued by Midwest Research Institute in early 1973 and may not reflect current competitive positions.)

3. Supply/Demand Trends

Table III-23 shows projected supply/demand trends to 1977 for bleached paperboard and folding and set-up recycled paperboard. Both bleached paperboard and folding recycled paperboard were in extremely tight

TABLE III-21

MAJOR U.S. RECYCLED BOXBOARD PRODUCERS

Producer	1973 Capacity[a] (000 tons/yr)	Percent Total U.S. Capacity
Container Corp.	422	13.3
Whippany	388	12.1
Federal Paperboard	282	8.9
Packaging Corp.	258	8.1
Sonoco Products	179	5.6
Fiberboard Corp.	170	5.3
Brown Company	151	4.7
Consolidated Packaging	142	4.5
Simkins Industries	107	3.4
Subtotal	2,096	65.9
Others (about 35)	1,086	34.1
TOTAL	3,182	100.0

[a] Includes folding and set-up boxboard

SOURCE: Lockwood's Directory of the Paper and Allied Trades, 1974

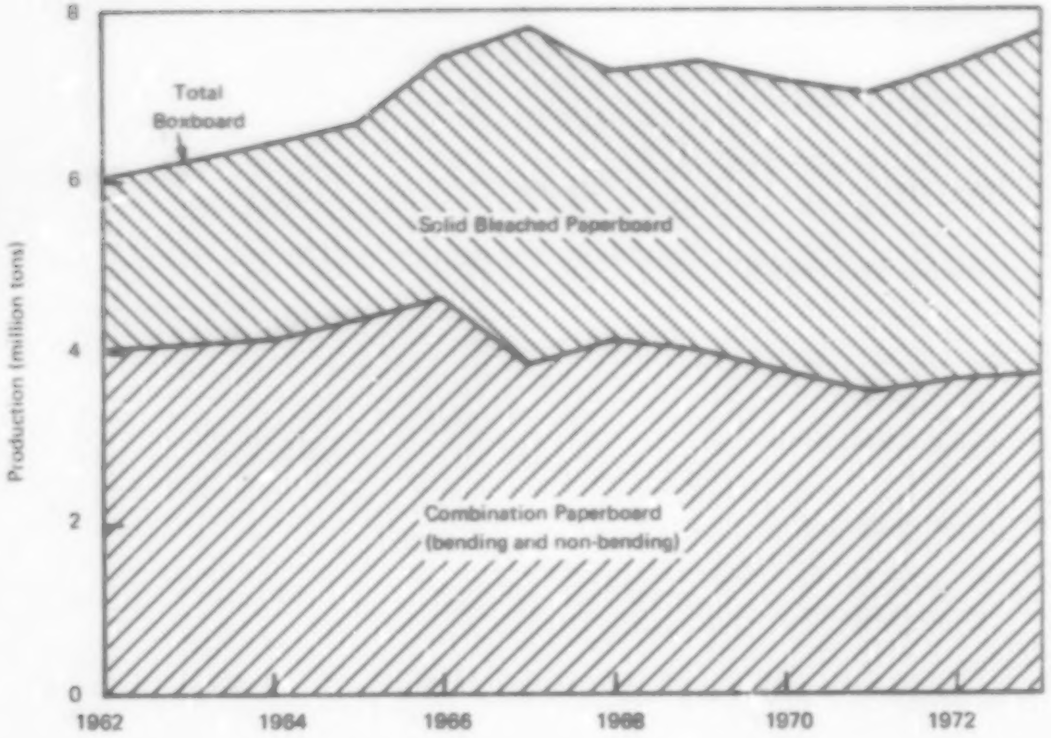

FIGURE III–4 U.S. PRODUCTION OF COMBINATION PAPERBOARD AND SOLID BLEACHED PAPERBOARD, 1962–1973

TABLE III-22

FACTORS RELATED TO THE USE OF RECYCLED FIBERS IN FOLDING CARTON END-USE MARKETS

		Performance Factor						
Market Category	Combination Paperboard % of Market	Economics	Gray Back Esthetics	Package Shelf Performance	Machin-Ability	Strength/ Weight Relation	Possible Health Factors	Comments
Medicinal	61	U	U	F	F	U	F	light caliper required-gray back shows less purity
Cosmetics	53	F	U	F	U	N	F	light caliper required-gray back shows less purity
Powdered Soap	95	F	F	F	U	U	F	heavy caliper required-gray back doesn't show
Food - Dry	80	F	U	F	U	U	U	heavier calipers required-gray back doesn't show
Food - Moist, Liquid, Oily	12	U	U	U	U	U	U	used only in prewrapped items - cheese, etc.
Candy	68	N	U	F	N	U	U	mostly used with inner wrap
Biscuits and Crackers	76	F	U	F	U	U	U	most all cartons have inner wraps
Perishable Bakery	41	F	U	F	N	U	U	gray back is usually laminated with greaseproof paper
Tobacco	54	U	F	F	F	U	F	heavy caliper for cigars, pipe tobacco; unsatisfactory for flip top box and cigarette cartons
Hardware	60	U	F	F	F	U	F	usually made extra strength kraft back
Sporting Goods and Toys	70	N	F	F	F	U	F	usually heavier caliper kraft back, esthetics less important
Textiles	72	F	U	F	F	F	F	usually heavier caliper
Retail and Laundry	83	F	N	F	F	F	F	requires lowest cost paperboard
Beverages	73	F	F	F	F	F	F	heavier caliper
Beverage Carriers	17	U	F	U	N	U	F	market lost to plastic for cans & some bottles
Paper Goods	80	F	U	F	F	U	F	large size cartons; board costs high factor

U - Unfavorable - Disadvantages to the use of recycled fiber.
F - Favorable - Recycled fiber can be used at no disadvantage.
N - Neutral.

Source: William E. Franklin, Paper Recycling: The Art of the Possible, 1970-1985, Report to the Solid Waste Council of the Paper Industry, (Kansas City, Mo.: Midwest Research Institute, March, 1973), p. 99.

TABLE III-23

BOXBOARD SUPPLY/DEMAND TRENDS

Product Category	Preliminary 1973 (000 tons)	Average Growth (%/yr)	Projected 1977 (000 tons)
BLEACHED PAPERBOARD			
Domestic demand	3,655	2.0	3,960
Exports and other	265	3.0	300
Total demand for U.S. Production	3,920	2.1	4,260
Capacity	3,928	1.9	4,237
Apparent Operating Rate	100%		100.5%
FOLDING RECYCLED PAPERBOARD			
Total Demand for U.S. Production	2,763	2.0	2,990
Capacity	2,664	1.6	2,836
Apparent Operating Rate	100.5%		105%
SET-UP RECYCLED PAPERBOARD			
Total demand for U.S. Production	465	-1.0	450
Capacity	518	0.4	527
Apparent Operating Rate	90%		85%
OTHER COMBINATION BOARD - NONBENDING			
Total demand for U.S. Production	526	2.0	570
Capacity	584	1.6	620
Apparent Operating Rate	90%		92%

SOURCES: Capacity and 1973 Demand - American Paper Institute; Demand Projections — Arthur D. Little, Inc.

supply in 1973; hence these should be similarly tight in 1977 as the economy recovers from the current recession. However, a number of recently announced bleached paperboard expansions due to come on stream in 1978 could cause a modest oversupply in that year. Demand for set-up recycled paperboard is declining slowly, partly due to competition from folding cartons and plastics; this trend is likely to cause an oversupply of set-up recycled boxboard by 1977 unless the equivalent of one mill is closed or shifted to other products by that time.

In years past, bleached paperboard displaced recycled paperboard in a number of folding carton operations. Because of this and the growth of its other markets, bleached paperboard demand grew about 5% per year during the 1950's and 1960's while the demand for recycled paperboard hardly grew at all. Now, however, the extremely rapid cost/price increases for bleached pulp have made bleached paperboard less cost-competitive with recycled paperboard in folding applications. Also, we expect renewed competition between plastics and bleached paperboard in milk cartons, cups, plates, and trays. Therefore, we project that bleached and recycled paperboard will grow at about the same rate, albeit a relatively slow one (roughly 2% per year).

4. Market Characteristics

a. Selling Prices

Table III-24 shows the recent price history of bleached paperboard and recycled boxboard. This points out the increasing price differential between the two products since 1973. Even at its current price, however, bleached paperboard is selling at about the same price as bleached market pulp, although it costs considerably more to produce. Therefore, bleached paperboard prices are likely to rise even higher relative to recycled boxboard, thus slowing the growth of the former and increasing the demand for the latter.

The prices in Table III-24 overstate the cost competitiveness of recycled boxboard. A smaller proportion of bleached paperboard is usually used, since it is stronger and has a lower density than recycled boxboard; thus, less bleached paperboard tonnage is needed for a given application.

b. Profitability

Like most other paper industry sectors, there are no publicly-held firms that specialize in either the bleached paperboard or recycled boxboard product lines. Therefore, profitability data are not published for these sectors. However, our previous experience with companies in these sectors indicates that the profitability of the bleached paperboard producers has been fairly consistently near the paper industry average, but the profitability of recycled boxboard producers has been below the industry average. The reasons are probably that (1) large capital requirements limit entry into the bleached paperboard sector, (2) its mills are more modern than most recycled boxboard mills, and (3) demand

TABLE III- 24

BLEACHED PAPERBOARD AND RECYCLED BOXBOARD PRICE TRENDS

($/ton)

Year		Solid Bleached Paperboard	Recycled Boxboard (20-Point Clay-Coated)
1973	January	210	152
1974	January	250	190
	March	280	220
	May	280	230
	September	320	260
	October	350	260
	November	350	280
1975	January	350	280

SOURCE: H.C. Wainwright and Company, industry price surveys.

for bleached paperboard has traditionally grown somewhat faster than the industry average. Conversely, entry into the recycled boxboard area has been relatively easy because of lower capital requirements; the result has been chronic oversupply in this traditionally very slow-growing product area.

5. Factors Affecting Increased Waste Paper Utilization

There appears to be relatively little prospect for using substantial amounts of waste paper in bleached paperboard. All the producers of this product are currently integrated to bleached kraft pulp and further integrated to the ownership of a substantial portion of the woodlands needed to support their pulp mills. Moreover, most of their mills are far from any metropolitan areas where a significant supply of waste paper might be obtained. Finally, this product requires a pulp substitute or a deinkable grade of waste paper, which traditionally has been in short supply relative to other grades. Another consideration is that the use of waste paper would probably necessitate costly testing procedures to guard against the introduction of impurities, so that the paperboard would be suitable for packaging food that comes in contact with the board. For the above reasons, we expect that only small amounts of waste paper will be utilized in bleached paperboard under special circumstances where an economical supply is available and where the paperboard is to be used primarily in nonfood applications.

The key factor to greater utilization of waste paper and recycled boxboard is to increase the demand for this packaging material vis-à-vis bleached paperboard and plastic. Several factors suggest that the growth of recycled boxboard can be stimulated: (1) the currently increasing price differential between recycled boxboard and bleached paperboard noted, (2) the possibility of making a higher quality board with the newer multi-ply board forming devices, and (3) removal of the stigma against recycled products.

In conclusion, for the reasons cited above and because of the high cost of building new grass-roots facilities for the manufacture of SBS board, we expect recycled board to maintain its competitive position with respect to the virgin fiber product.

G. PRINTING, WRITING AND RELATED PAPERS

1. Products Included

The printing, writing, and related papers sector consists of four product groupings: coated printing and converting paper, uncoated book paper, writing and related papers, and bleached bristols. All of these papers employ bleached pulp and are used primarily for printing, publishing, stationery, and a variety of paper converting applications. Some of this is sold by the producer directly to large customers; the rest is sold through paper merchants or other wholesalers to small printers, publishers, and paper converters. The paper is usually cut by the paper mill in rolls or sheets ready for final use. Table III-25 shows the 1973 production volumes and principal grades included within these four categories.

Two-side coated printing and converting paper is used primarily for magazine and textbook printing. The kind used in magazines, which constitutes about 70% of the volume, utilizes a groundwood-content base paper containing about 50% groundwood and 50% chemical pulp. Textbooks and publications such as corporate annual reports and advertising brochures generally utilize a 100% chemical pulp base sheet. The coated one-side papers are generally used for labels and packaging wraps, such as on cans; these generally utilize a 100% chemical pulp base sheet. Since most coated papers are used by large customers, they are generally sold direct by the paper manufacturer.

Uncoated book paper is used for many applications in addition to book printing. These include a wide variety of commercial printing applications that require uncoated paper as well as the paper used to produce envelopes and tablets. With the exception of the envelope and tablet converting applications, most purchases of uncoated book paper are relatively small accounts, and hence a large volume of this paper is sold through paper merchants. Few manufacturers have the breadth of product line or dominant share of the large accounts to economically sell direct to this market, which consists of over 15,000 commercial establishments. These papers are differentiated from the uncoated groundwood papers in that they contain no more than 25% groundwood pulp in their furnish.

Writing and related papers are primarily used for business writing papers, stationery, and business forms. Forms for computer printing and a variety of other business forms is the largest volume grade in this category, accounting for over 25% of 1973 production. The cotton-fiber papers have furnishes containing 25% or more of cotton, rags, linters, flax, or similar fibers. They are more expensive than the chemical wood pulp writing papers and hence are used in higher-value specialized applications, such as chart papers and special stationery. Thin papers include carbonizing tissue, condenser tissue, cigarette paper, pattern paper and the like.

TABLE III-25

U.S. PRODUCTION OF PRINTING, WRITING, AND RELATED PAPER PRODUCTS, 1973

Product Category	Production 000 Tons	 % of Total
Coated Printing and Convering		
Coated, two sides	3,389	31.7
Coated, one side	457	4.3
Subtotal	3,846	36.0
Uncoated Book Paper		
Publication and Printing	2,011	18.8
Body Stock for Coating	27	0.2
Other	1,024	9.6
Subtotal	3,062	28.6
Writing and Related Papers		
Writing, Chemical Wood Pulp	3,091	28.9
Writing, Cotton Fiber	124	1.2
Cover and Text	221	2.1
Thin Paper	345	3.2
Subtotal	3,781	35.4
TOTAL	10,689	100.0

Forms bond and thin papers are generally sold direct, since most of the customers are large converters. A significant volume of bond and stationery paper, however, is sold through paper wholesalers, because the stationery converting market is highly fragmented.

2. Industry Structure

Table III-26 lists the 14 major U.S. printing and writing paper producers and their share of U.S. capacity in 1973. The market is relatively fragmented compared with most other paper and paperboard product sectors: the 14 largest producers account for only 47% of U.S. capacity, and at least 60 other firms compete in this sector.

A look at specific grades within the printing and writing category, however, reveals that some companies have a more dominant position. Consolidated Papers, for example, has nearly a 10% share of the total U.S. capacity for coated papers and an even larger share of the magazine paper market, in which it specializes. Great Northern-Nekoosa focuses primarily on the writing paper sector, and even more specifically on forms bond, in which it is the leading producer; however, it has only a 5% share of the uncoated book and chemical wood pulp writing papers category. The bleached bristol category is particularly concentrated: Boise Cascade, Eastex, and Scott Paper Company (all of whom produce bleached paperboard for packaging applications at the same mills) are the only significant U.S. producers.

All of the bleached bristol producers are integrated to chemical pulp production on site, as are most of the printing and writing paper mills operated by the 14 largest companies in this sector. However, a substantial number of nonintegrated printing and writing paper mills rely primarily on purchased chemical pulp and, to a far lesser degree, on pulp substitute grades of waste paper. In this sector, only Bergstrom Paper Company relies entirely on deinked waste paper, and it currently has about a 1% share of total U.S. printing and writing paper capacity.

3. Supply/Demand Trends

Table III-27 shows 1973 operating rates for major product categories within the printing, writing, and related paper sector and projects their operating rates to 1977. It indicates that with the anticipated recovery from the current recession, the coated paper, uncoated book, chemical writing and thin paper, and solid bleached bristol product categories should reestablish by 1977 the extremely high operating rates they enjoyed in 1973.

Cotton fiber writing paper is the only category that is likely to experience a drop in operating rates by 1977; however, the mills in this category characteristically maintain relatively low operating rates compared with other categories in the printing and writing paper sector.

We expect the highest rate of growth in demand to occur in the uncoated book, chemical writing, and thin paper category, although only slightly

TABLE III-26

CAPACITIES OF MAJOR U.S. PRINTING AND WRITING PAPER PRODUCERS, 1973

Company	Capacity* (000 tons)	% of U.S. Capacity
Mead Corp.	688	6.2
International Paper	557	5.0
Hammermill	473	4.3
Weyerhaeuser	438	4.0
Westvaco	437	3.9
Scott Paper	420	3.8
Consolidated Papers	399	3.6
Great Northern Nekoosa	333	3.0
Potlatch Forests	285	2.6
Oxford Paper	280	2.5
Allied Paper	280	2.5
Champion International	270	2.4
Georgia-Pacific	259	2.3
Finch Pruyn	245	2.2
Subtotal	5,364	48.4
Others	5,713	51.6
TOTAL	11,077	100.0

*Excludes capacity for bristols which are usually produced by mills making solid bleached paperboard.

SOURCE: Lockwood's Directory of the Paper and Allied Trades, 1974.

TABLE III-27

PRINTING, WRITING, AND RELATED PAPER SUPPLY/DEMAND TRENDS

Product Category	Preliminary 1973 (000 tons)	Average Growth (%/Yr)	Projected 1977 (000 tons)
COATED PRINTING & CONVERTING			
Total demand for U.S. Production	3,846	3.5	4,410
Capacity	4,045	3.4	4,621
Apparent Operating Rate	95%		96%
UNCOATED BOOK, CHEMICAL WRITING, AND THIN			
Total demand for U.S. Production	6,719	4.0	7,860
Capacity	6,883	4.4	8,162
Apparent Operating Rate	98%		97%
COTTON FIBER WRITING PAPERS			
Total demand for U.S. Production	124	-	120
Capacity	149	0.6	153
Apparent Operating Rate	83%		78%
SOLID BLEACHED BRISTOLS			
Total demand for U.S. Production	1,133	1.4	1,200
Capacity	1,199	2.1	1,279
Apparent Operating Rate	96%		94%

SOURCES: Capacity and 1973 Demand - American Paper Institute; Demand Projections - Arthur D. Little, Inc.

above that of our assumed growth of real GNP of 3.5%/year. Within this category, computer forms bond is growing at an above-average rate, while uncoated book and stationery paper is growing at about an average rate and thin papers are below average. In the coated papers sector, magazine applications are growing only about 3% per year, but somewhat higher growth is expected in textbooks and other coated paper applications.

4. Market Characteristics

A. Price Trends

As with most other paper products, printing and writing paper prices rose rapidly after price controls were lifted in March 1974. Throughout most of the 1960's, prices had been very stable in comparison with the all-commodity price index. Table III-28 shows the trend in printing and writing paper prices since 1970.

The recent price increases were caused by a very tight supply/demand balance for printing and writing papers, coupled with rapidly rising costs, particularly for bleached chemical pulp. In fact, producers that were not integrated to pulp production were barely able to maintain their profit margins in the face of rising market pulp prices, in spite of the price increases they obtained on their end products. Producers that were integrated to pulp, however, were able to obtain significant profit margin improvements.

b. Profitability

Only a few publicly-owned paper companies specialize in the printing and writing paper product line. According to their earnings statements, companies that are integrated to pulp production have fairly consistently had profit margins close to the average for the paper and allied products industry. On the other hand, companies not integrated to pulp have been fairly consistently below the industry's profitability average. The profits of Bergstrom Paper Company, the only firm that uses a 100% waste paper furnish, have been consistently above the industry average.

5. Factors Affecting Increased Waste Paper Utilization

A substantial amount of waste paper is already used in making printing and writing papers, primarily in blends with bleached chemical pulp. In 1973, about 940,000 tons of waste paper, primarily the pulp substitutes or deinking grades, were used in printing and writing paper and accounted for about 7% of the total fiber furnish. The current waste paper utilization rate, coupled with the fact that the demand for printing and writing papers is growing faster than for most any other paper products, make this sector a promising one for increased waste paper utilization. Furthermore, many printing and writing paper mills are relatively close to areas of concentrated population from which they can obtain an economical supply of waste paper.

TABLE III -28

PRINTING AND WRITING PAPER PRICE TRENDS

(Dollars Per Ton)

	Uncoated Tablet Paper (16 lb.)	Register Bond (12 lb.)	Uncoated Book Paper (No. 3 Offset)	Coated Publication Paper (34-36 lbs.)
January 1973	222	n.a.	n.a.	255
February	222	n.a.	n.a.	264
March	250	324	365	270
January 1974	260	363	412	280
February	265	n.a.	n.a.	285
March	290	n.a.	n.a.	300
April	290	n.a.	n.a.	340
July	350	n.a.	475	360
October	350	470	500	400
January 1975	360	490	535	400
% Growth (3/73-1/75)	44%	51%	47%	48%

n.a.--not available.

SOURCE: H.C. Wainwright and Company, producer surveys.

Perhaps the most important factor affecting increased waste paper utilization is the rapidly rising price of bleached market pulp. Many of the printing and writing paper mills are not integrated to pulp, and as its price continues to rise, it increases the incentive for these mills to substitute waste paper for virgin pulp.

On the other hand, most grades of printing and writing papers require an extremely clean, white pulp. To obtain these qualities from waste paper, the mills must almost invariably install deinking facilities, since the supply of pulp substitute grades of waste paper is already spoken for. Deinking facilities are costly to build (although not as costly as a minimum economic-sized chemical pulp mill) and create a substantial water pollution problem; the latter necessitates the expensive primary and secondary treatment facilities, which add to the cost and space requirements.

A second inhibiting factor is that the easily obtainable supply of deinking grades of waste paper has already been tapped, and higher waste paper prices will be required to attract a significant supply of sorted post-consumer waste paper suitable for deinking. However, the continued rise in the price of bleached chemical pulp is likely to cause a corresponding increase in deinking waste paper prices.

H. INDUSTRIAL PACKAGING AND MISCELLANEOUS CONVERTING PAPERS

1. Products Included

Table III-29 lists the major products comprising the industrial packaging and miscellaneous converting paper functional group. The group consists of three major categories:

- Unbleached kraft paper, used primarily for wrapping paper, shipping sacks, multi-wall bags, and grocery sacks and bags;
- Bleached kraft (and, to a lesser extent, sulfite) packaging papers which are utilized for a variety of specialty wrapping, bag, and food carton inner-wrap applications; and
- Other converting paper and paperboard applications, including special industrial paper, tube, can, and drum paperboard, and other specialty recycled paperboard applications.

The unbleached kraft paper sector is characterized by long, large-volume production runs. Most of the manufacturers produce linerboard (and other containerboard materials as well) since these products use the same type of pulp, i.e., primarily unbleached softwood southern pine. The producers also have a major share of the multi-wall bag and grocery

TABLE III-29

PRODUCTION OF INDUSTRIAL PACKAGING AND MISCELLANEOUS CONVERTING PAPERS, 1973

Grades	Production 000 tons	 % of Total
Unbleached Kraft Packaging and Industrial Converting		
Wrapping	248	
Shipping sack	1,133	
Bag and sack, excluding shipping	1,987	
Other converting	643	
Subtotal	4,011	50.6
Packaging and Industrial Converting, Excluding Unbleached Kraft		
Wrapping	168	
Shipping sack	102	
Bag and sack exc. shipping	254	
Other converting	497	
Glassine, greaseproof, and vegetable parchment	236	
Subtotal	1,258	15.9
Other Converting Paper and Paperboard		
Special industrial paper	564	7.1
Tube, can and drum paperboard (recycled)	901	11.4
Special combination paperboard	1,191	15.0
TOTAL	7,925	100.0

Source: Bureau of the Census, Industry Division, Pulp, Paper and Board and American Paper Institute (tube, can and drum and special combination paperboard.)

bag and sack converting markets. Substitution of plastic film, particularly for the multi-wall bags and, to a lesser extent, shopping bags, has caused demand for unbleached kraft paper to remain static in these areas.

Bleached packaging and industrial converting papers have much the same applications as unbleached kraft paper, but the end uses are highly fragmented and more in the nature of commodities. Glassine, greaseproof, and vegetable parchment are used as inner linings for packages (e.g., dry cereal and cake mixes), specialty bags, and a variety of other products. They are produced from a variety of bleached and unbleached softwood kraft and softwood sulfite pulp. Substitution by plastics has been even more substantial here than with unbleached kraft paper and is likely to continue.

The other converting paper and paperboard sector consists of a number of grade categories which utilize waste paper extensively. The special industrial paper category is made up of a variety of paper and paperboard grades designed for specialized end uses such as abrasive paper, absorbent paper, cable paper, electrical insulation, vulcanized fiber, and resin impregnating stock. The tube, can, and drum paperboard category consists of the recycled paperboard component only. Unbleached kraft paperboard use in this application is included in the containerboard functional group, because tubes and drums are small-volume application. This material is used to produce spiral-wound cans and drums. The special combination paperboard category consists of uses for recycled paperboard not included elsewhere, such as tags, file folders, match stems, tablet backs, toys, etc.

Although substantial amounts of waste paper are used in the production of special industrial grades, many grades use 100% chemical pulp, often of the long-fiber variety made by the kraft or cotton linters process.

2. Industry Structure

Table III-30 lists the 1973 capacities of the ten largest producers of unbleached kraft and other packaging and industrial converting papers. These firms concentrate on the production of unbleached kraft grades as opposed to the other packaging and converting grades. Together, they account for over 50% of U.S. unbleached kraft paper capacity. All are vertically integrated from woodlands to the converting and marketing of multi-wall grocery and other bags.

Thilmany Pulp and Paper Company is the largest producer of packaging and converting papers other than unbleached kraft and is one of the few that specialize in this product line. This industry sector, however, is much more highly fragmented than the unbleached kraft papers sector; many companies produce these grades as a small part of their total production. In addition, there is a much lower incidence of complete vertical integration of woodlands to converted product.

Table III-31 shows the major producers of special industrial paper. Although the average producer is relatively small (under 100,000 tons/year), there is a fair degree of concentration in this sector: the top ten firms

TABLE III-30

CAPACITIES OF MAJOR PRODUCERS OF UNBLEACHED KRAFT AND OTHER PACKAGING AND INDUSTRIAL CONVERTING PAPER PRODUCTS, 1973

Company	Capacity	
	(000 tons)	(% of Sector Total)
International Paper	568	10.5
St. Regis	441	8.1
Union Camp	320	5.9
Crown Zellerbach	411	7.6
Longview Fibre	230	4.2
Hudson Pulp and Paper	195	3.6
Gulf States Paper	177	3.3
Hoerner Waldorf	177	3.3
Georgia-Pacific	156	2.9
Thilmany Pulp and Paper	142	2.6
Subtotal	2,817 +	51.9 +
Other Producers	2,613	48.1
TOTAL	5,430	100

SOURCE: Lockwood's Directory of the Paper and Allied Trades, 1974, and American Paper Institute capacity survey.

TABLE III-31

CAPACITIES OF MAJOR PRODUCERS OF SPECIAL INDUSTRIAL PAPER, 1973

Company	Capacity	
	(000 tons)	(% of Sector Capacity)
Homosote Company	113	17.9
Riegel Products Corporation	55	8.7
Standard Packaging	42	6.7
Hollingsworth and Vose	39	6.2
Fitchburg Paper	32	5.1
Schoeller Technical Division of Mead	24	3.8
Allied Paper	24	3.8
Nicolet Industries	23	3.7
Beverage Paper	23	3.7
Rochester Paper	23	3.7
Subtotal	398	63.3
Other Producers	231	36.7
TOTAL	629	100.0

Source: ADL calculations based on data from Lockwood's Directory, 1974 account for over 60% of the total capacity in this highly specialized product line. Most producers are not integrated to pulp production but rely on purchased pulp or waste paper for their fiber requirements.

Tube, can, and drum paperboard and special combination paperboard are often produced as a relatively small portion of the product lines of the recycled boxboard companies. Sonoco Products Company is one of the few major firms to concentrate their production of several of its mills in this product area. Sonoco has about a 12% share of U.S. capacity for recycled tube, can, and drum paperboard and about a 5% share of this sector plus special combination paperboard. Thus, the market is relatively fragmented. In most respects, it has the same characteristics as the recycled folding boxboard sector, except that there is little or no forward integration to converting.

3. Supply/Demand Trends

Table III-32 shows the projected 1977 supply/demand balances for each of the major grades that make up the Industrial Packaging and Converting Papers functional group. In each case, 1977 operating rates are expected to be about equal to the fairly high rates that prevailed in 1973.

The rate of growth in demand for unbleached kraft and other packaging papers is very low, as we have noted earlier, primarily because of displacement by plastic films. However, since the rate of capacity expansion for these papers is also low, a tight supply/demand balance should be reestablished when the U.S. economy recovers from the current recession.

Because of its specialty product nature and the highly fragmented lines of most producers, special industrial paper is not a typical pulp and paper product: a 90-92% operating rate is about the practical maximum for this grade over the course of a year. Here again, the growth in capacity approximates the projected growth in demand between 1973 and 1977, indicating that a relatively tight supply/demand balance will prevail.

A similar projection holds for special recycled packaging and converting paperboard.

The key implication of these trends is that the upward movement in prices and profitability in these grades that occurred in 1972-1974 should be reestablished with the anticipated recovery of the U.S. economy in 1976.

4. Market Characteristics

a. Price Trends

Table III-33 shows price trends in the major unbleached kraft packaging paper grades since January 1973. It indicates that the prices of both the multi-wall bag and grocery bags have risen 61%, mostly since March 1974,

TABLE III-32

SUPPLY/DEMAND TRENDS FOR INDUSTRIAL PACKAGING, CONVERTING, AND MISCELLANEOUS PAPERS

	Preliminary 1973 (000 tons)	Average Growth (% Year)	Projected 1977 (000 tons)
UNBLEACHED KRAFT PAPER			
Demand for U.S. Production	4,011	1.2	4,200
Capacity	4,138	1.0	4,303
Apparent Operating Rate	97%		98%
OTHER PACKAGING PAPER			
Demand for U.S. Production	1,258	0.2	1,270
Capacity	1,292	0.3	1,306
Apparent Operating Rate	97%		97%
SPECIAL INDUSTRIAL PAPER			
Demand for U.S. Production	564	3.5	650
Capacity	629	3.2	713
Apparent Operating Rate	90%		91%
SPECIAL RECYCLED PACKAGING PAPERBOARD*			
Demand for U.S. Production	1,540	4.0	1,800
Capacity	1,637	3.7	1,895
Apparent Operating Rate	94%		95%

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* Includes tube, can, and drum stock; 1973 data from API

TABLE III-33

PRICE TRENDS FOR UNBLEACHED KRAFT PAPERS
($/ton)

	50-lb Multi-Wall	57-lb Grocery Bag
January 1973	165	155
March	175	165
August	180	170
March 1974	200	180
August	240	220
November	250	230
December	250	235
January 1975	265	250
Total Increase	61%	61%

Source: H.C. Wainwright & Co., producer survey.

when price controls were partially lifted for the U.S. pulp and paper industry.

The prices for these grades had been essentially stable during the 1960's because of the general condition of overcapacity, intense competition from plastics, and productivity improvements in kraft paper production. However, as the supply/demand balance tightened in 1973, the producers found that they could pass on their cost inflation as well as improve their profit margins by increasing prices.

Published data are not available on price trends for specialty packaging papers and special industrial papers and paperboard. Many of these grades are produced from purchased and/or bleached pulps whose prices have risen faster than those of commodity products produced in mills fully integrated to pulp production. Therefore, we believe that the rate of price increase for these grades since January 1973 is comparable to that of the printing and writing paper grades.

Price trends for recycled tube, can, and drum paperboard and special combination board also are not published, but we believe them to be somewhat steeper than the recent increases in recycled folding boxboard.

b. Profitability

As there are a variety of products, so also are there several general profitability levels in the industrial packaging and miscellaneous converting paper group. The most profitable product line in this group appears to be the specialty packaging and industrial converting papers made by fully integrated producers; their profitability probably exceeds that of the entire paper and allied products industry.

On average, the large producers of unbleached kraft packaging and converting papers are currently achieving a profitability close to the industry average. Probably ranked immediately below them are producers of special combination paperboard, followed by producers of recycled tube, can, and drum paperboard. The average special industrial paper producer probably ranks last in terms of profitability in this sector, well below the paper industry average; most producers in this sector rely extensively on purchased market pulp and have been unable to pass on all of the price increases they have had to pay for this raw material.

5. Factors Affecting Increased Waste Paper Utilization

The unbleached kraft papers are analogous to kraft linerboard from the standpoint of being a large-volume commodity group grade which, while attractive from a volume standpoint, will be very difficult for waste paper to penetrate substantially, either as a pulp substitute or as a product replacement. Most producers of this material also make linerboard, often in the same mill, so their orientation to the use of virgin fiber as a result of their backward integration to woodland control applies to both products. Unlike the case with linerboard, however, we know of no producer who makes unbleached kraft paper from 100% waste paper; this demonstrates that unbleached kraft paper, which is a lighter product and yet has quite stringent strength requirements, poses even greater obstacles to a 100% waste paper product.

There is likely to be greater opportunity for higher waste paper ratios in the specialty packaging and converting papers area, particularly for nonintegrated pulp producers that are facing steeply rising market pulp prices.

Substantial quantities of waste paper are already used in the special industrial paper, special combination paperboard, and tube, can, and drum paperboard areas. Somewhat higher usage ratios might be used by nonintegrated producers of special industrial papers to help offset the rapid rise in market pulp prices, but most of the increase in waste paper utilization is likely to result from greater production of these products. This subject is further discussed in Sections VIII and X.

I. CONSTRUCTION PAPER AND PAPERBOARD

1. Products Included

The Construction Paper and Paperboard functional group consists of a number of fibrous materials that are primarily used in the building industry. For the purposes of this report, the group is divided into three subcategories--construction paper, gypsum wallboard, and hardboard/insulation board.

Construction paper includes sheathing paper, felts (roofing, floor covering, automotive, sound deadening, industrial, pipe covering, refrigerator, etc.), asbestos and asbestos-filled paper, and flexible wood-fiber insulation. Except for asbestos paper, these materials are usually made entirely of waste paper. Almost all forms of construction paper are intermediate products.

Gypsum linerboard, another intermediate product, is the facing material on gypsum wallboard. It is made entirely from waste paper. Gypsum wallboard is used chiefly for interior wall and ceiling panels and as a base for plaster.

Hardboard and insulation board are quite dissimilar to the other products in this functional group. Neither is produced on a conventional Fourdrinier or cylinder board machine nor in any way resembles a paper product. They are generally not made by the manufacturers of paper or paperboard, and they are sold to different markets. Waste paper has not been used in these materials in the past; they are usually made from wood residues or sometimes waste wood. However, recent experimental work indicates that substantial amounts of secondary fiber could be used. (See Section VIII, Substitutability of Secondary Fiber.)

Hardboard (or hard-pressed board) is usually made from long-fiber mechanical pulp into a fiberboard that may be treated and/or tempered. Typical densities are in the range of 40-90 pounds per cubic foot. This product is used for such applications as cabinet backing and wall paneling.

Insulation board is a homogeneous wood fiber panel made by interfelting the fibers from defibrated pulp. The semi-rigid variety has a density of 9.5 pounds per cubic foot or less and is used for insulation purposes such as ceiling tile and acoustical tile. Rigid insulation board has densities ranging from 9.5 to 31 pounds per cubic foot and is used for such applications as exterior sheathing, interior wall paneling, and as a base for plaster or siding.

2. Industry Structure

Tables III-34 and -35 show the capacity shares of the major producers of construction paper and gypsum linerboard respectively. Both markets, particularly the latter, are highly concentrated from a supply standpoint. All of the construction paper producers are integrated forward to the conversion of final products such as shingles, tar paper, and sheathing paper; their plants are generally near major metropolitan areas, which provide a supply of waste paper as well as the primary market for the end product. Similarly, all the gypsum linerboard producers make gypsum wallboard in plants that are close to a source of gypsum.

Table III-36 lists the major producers of hardboard and insulation board and their share of total production capacity. The hardboard market is highly concentrated, as the five top producers account for about 52% of total capacity. The insulation board sector is almost as concentrated, with the five top producers accounting for 48% of capacity.

The largest centers of hardboard and insulation board production are in the North Central, Western, and Southern regions. Most of the major producers are integrated back to woodland control, although not specifically for these products, since they are made primarily from sawmill and plywood mill wood residues.

3. Supply/Demand Trends

Table III-37 shows projections of supply and demand for the various sectors of the Construction Paper and Paperboard functional group. In all of these sectors, 1977 operating rates are likely to be about as high as those that prevailed in 1973. Demand in all sectors is highly sensitive to construction industry activity, and our demand projections assume that housing starts will return to an annual level of about two million by 1977.

TABLE III-34

MAJOR PRODUCERS OF CONSTRUCTION PAPER

Company	1973 Capacity (000 tons)	% of Sector Total
Celotex Company	358	17.0
GAF Corp	367	17.5
Lloyd A. Fry Roofing	240	11.4
Certain-Teed Products	218	10.4
Bird & Son	175	8.3
Johns Manville	195	9.3
Subtotal	1,533	73.9
Other Producers	549	26.1
TOTAL	2,102	100.0

SOURCES: Lockwood's Directory of the Paper and Allied Trades, 1974, and American Paper Institute Capacity Survey, 1974.

TABLE III-35

MAJOR PRODUCERS OF GYPSUM LINERBOARD

Company	1973 Capacity (000 tons)	% of Sector Total
National Gypsum	411	37.6
U.S. Gypsum	259	23.7
Georgia Pacific	121	11.1
Celotex	104	9.5
Subtotal	895	81.9
Other Producers	198	18.1
TOTAL	1,093	100.0

SOURCES: Lockwood's Directory of the Paper and Allied Trades, 1974 and American Paper Institute Capacity Survey, 1974.

TABLE III-36

CAPACITIES OF MAJOR PRODUCERS OF HARDBOARD AND INSULATION BOARD

Company	Percent of Total Industry Capacity
A. Hardboard[a]	
Masonite	34
Abitibi	8
Superwood	6
U.S. Plywood (Champion International)	5
Georgia-Pacific	5
U.S. Gypsum	5
Celotex (Jim Walter)	5
Evans Products	4
B. Insulation Board[b]	
Celotex	19
Boise Cascade	13
Armstrong Cork	12
Weyerhaeuser	8
U.S. Gypsum	8
Temple Industries	7

SOURCES:

a. Annual reports, company data, and contractors' estimates.

b. Arthur D. Little, Inc., "Economic Analysis of Proposed Effluent Guidelines," EPA 230/2-74-029, August 1974.

TABLE III-37

CONSTRUCTION PAPER AND BOARD SUPPLY/DEMAND TRENDS

	Preliminary 1973 (000 tons)	Average Growth (%/yr)	Projected 1977 (000 tons)
CONSTRUCTION PAPER			
Demand for U.S. Production	1,812	3.2	2,060
Capacity	2,102	1.8	2,258
Apparent Operating Rate	86%		91%
GYPSUM LINERBOARD			
Demand for U.S. Production	1,050	1.2	1,100
Capacity	1,093	0.9	1,135
Apparent Operating Rate	96%		97%
HARD PRESSED BOARD			
Demand for U.S. Production	2,087	3.6	2,400
Capacity	2,247	2.2	2,452
Apparent Operating Rate	93%		98%
INSULATING BOARD			
Demand for U.S. Production	1,659	3.6	2,000
Capacity	1,837	3.8	2,136
Apparent Operating Rate	90%		94%

Source: 1973 demand - API Statistics of Paper
1973 capacity - API Capacity Survey Data, 1973-1976
1977 projections - Arthur D. Little, Inc., calculations of apparent operating ratios

4. Market Characteristics

a. Price Trends

Most forms of construction paper and all gypsum linerboard are, as previously mentioned, intermediate products and therefore have no established selling price. Although the retail prices of the final products could be ascertained, they would not necessarily reflect trends in the cost of the intermediate materials.

Prices of hardboard and insulation board have been depressed because of the economic slowdown and are presently around $60/MBF. (Since these products are not commodities, various prices apply to both, depending on the characteristics of the specific grade considered.) Prices are expected to recover in the foreseeable future with the upturn in the economy but are unlikely to return to the high levels reached in early 1974.

b. Profitability Trends

The profitability of most of the products in this functional group varies chiefly in accordance with construction industry cycles. Since the construction industry is now in a slump, the profitability from producing insulation board, hardboard and, to a lesser extent, construction paper is below the current average for the paper and allied products industry. Construction paper is somewhat sheltered from dips in the housing market, because it is buoyed up by increased use in reconstruction, remodeling, and roof replacement. These activities tend to keep the supply/demand balance in relative equilibrium.

Gypsum linerboard is an exception to the above generalization. There is no market for gypsum linerboard per se, since all of the producers are integrated to the production of gypsum wallboard. Thus, the profitability of gypsum linerboard depends on the internal transfer prices that are used. Basically, however, it is tied to the profitability of gypsum wallboard, which fluctuates in accordance with the U.S. supply/demand balance. Because of the softness in the construction market, wallboard profits are down.

5. Factors Affecting Increased Waste Paper Utilization

There is already substantial use of waste paper in the building paper and board functional group, except for hardboard and insulation board, which currently use no waste paper at all. In these two product areas, waste paper would have to compete economically against the even less expensive wood residue now used as raw material. In addition, if waste paper is to be used, new technology must be developed to obtain the extremely low density yet adequate bonding required for insulation board and the very dense, highly bonded properties of hardboard. Penetration into these product areas would result in significant tonnage utilization, because of the large size of the market and reasonably rapid growth rate, particularly for hardboard.

With regard to construction paper and gypsum linerboard, increased waste paper utilization will depend upon the growth of these product lines, since waste paper has probably reached its maximum share of the total raw materials used for these products. As indicated in subsection 3, both gypsum linerboard and construction paper are mature products, but have a reasonably attractive growth outlook, about in line with the overall construction industry index.

J. MARKET PULP

The purpose of this section is to analyze the supply/demand/price trends for pulps sold as an intermediate product for papermaking (i.e., market pulp) and against which waste paper competes as a substitute raw material.

1. Products Included

Market pulp includes all grades of papermaking pulp that are sold for subsequent fabrication into paperboard or other disposable products. The principal grades include bleached, semibleached, and unbleached sulfate (kraft) and sulfite pulps and bleached and unbleached groundwood pulps. In fact, the only grade not included is semichemical pulp, which to our knowledge is entirely produced captively by paperboard and paper producers.

In this analysis, we will focus our attention on the bleached and semibleached grades of kraft and sulfite pulp, as these currently constitute about 86% of the total pulp purchased by U.S. mills that are not integrated or are only partially integrated to on-site pulp production. The primary products produced by such mills are printing and writing papers, sanitary tissue, and related papers. We have excluded dissolving pulps, which are used primarily in nonpaper applications such as rayon and acetate fibers, cellophane, and a variety of cellulosic chemicals. Most dissolving pulp mills, however, also produce bleached paper-grade pulps and thus are considered from the supply point of view.

Although data are not readily available concerning the quantities of market pulp used in the manufacture of the various functional groups studied in this analysis, the information previously presented indicates that it is used primarily in the nonintegrated printing, writing, and tissue mills located in the North Central and Northeast regions. The relative amounts of softwood and hardwood pulp used in these grades are discussed in Section VIII-F and G.

2. Supply/Demand Trends

Table III-38 shows trends in U.S. capacity, production, imports, exports, and apparent consumption of bleached paper-grade pulps over the past five years. During this period, the capacity for bleached sulfite pulp declined and then grew modestly, while the rate of capacity expansion for bleached kraft pulp slowed appreciably to a 3.3% annual average between 1971 and 1974. In contrast, bleached pulp capacity grew 5.7% per year between 1969 and 1971 and 7.9% per year during the previous ten years. The recent slower growth, coupled with a strong surge in the U.S. and world consumption of bleached pulps in 1972 and 1973, brought about an extremely tight supply condition with shortages in 1973 and the first half of 1974.

Market pulp currently accounts for 32% of the total U.S. consumption of bleached paper-grade pulp; the remaining 68% is produced and consumed by paper and paperboard mills integrated to pulp. Canadian imports currently supply 53% of the bleached market pulps consumed in the United States. In the past, the supply from Canada has been ample: throughout the 1960's and through 1971, Canadian pulp producers operated at 83-90% of capacity, while meeting the needs of the U.S. market. In 1973 and 1974, however, Canadian producers operated at near full capacity except during mill and railroad strikes, which retarded Canadian exports, especially during 1973.

Since market pulp is traded internationally, the world supply/demand situation strongly affects the price and consumption of this commodity and, thus, the likelihood that nonintegrated paper manufacturers may elect to use recycled fiber as a substitute.

Bleached sulfite pulp mills currently supply about 16% of the world demand for bleached papermaking pulp. According to the latest survey of producers' expansions plans by the Food and Agricultural Organization of the United Nations (FAO), world capacity of bleached sulfite pulp mills is expected to remain constant at about 6.2 million metric tons through 1978 (Table III-39). In fact, this capacity projection may be optimistic in light of the potential closings of sulfite mills (particularly in Canada and Scandinavia) that are too small to justify the cost of installing water pollution abatement facilities. Therefore, demand will be supply-constrained, and the only potential new supply of bleached sulfite pulp will come from a shift in product mix on the part of sulfite dissolving pulp mills.

Currently, about 2% of the world demand for bleached papermaking pulp is supplied by mills that predominantly produce dissolving pulp. We foresee a gradual decline in the demand for dissolving pulp, because its major applications (cellulosic fibers) are being displaced by polyester and nylon and its next largest application (cellophane) faces continued substitution by plastic films. This, coupled with an anticipated increase in free-world dissolving pulp capacity of only 3.7%

TABLE III-38

U.S. CAPACITY, PRODUCTION, TRADE, AND CONSUMPTION OF BLEACHED PAPER-GRADE PULP, 1969-1974

(000 short tons, except as noted)

	Capacity							
	Bleached Sulfite	Bleached Kraft[a]	Total	Production	Capacity Utilization (%)	Imports	Exports	Apparent Consumption[b]
1969	2,001	12,706	14,707	13,939	94.8	2,965	1,210	15,694
1970	1,968	13,538	15,506	14,983	96.6	2,611	1,926	15,668
1971	1,949	14,206	16,155	14,650	90.7	2,599	1,216	16,033
1972	1,949	14,744	16,693	15,766	94.1	2,796	1,376	17,186
1973	1,977	15,436	17,413	16,783	96.4	3,057	1,524	18,315
1974[c]	1,991	15,647	17,694	17,462	98.7	3,214	1,548	19,128

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[a] Includes semi-bleached kraft pulp.

[b] Production plus imports minus exports

[c] First-half annual rate.

Sources: Capacity and production: American Paper Institute

Imports and exports: Bureau of Census, U.S. Department of Commerce.

TABLE III-39

WORLD CAPACITY TRENDS FOR BLEACHED SULFITE PULP
(000 metric tons)

Country or Region	1973	1978	Change Tonnage	Change Percent
United States	1,782	1,561	(221)	(12.4)
Canada	585	710	125	21.4
Sweden	1,025	860	(165)	(16.1)
Finland	560	520	(40)	(7.1)
Other Western Europe	1,695	1,991	296	17.5
Eastern Europe	377	425	48	12.7
Latin America	117	86	(31)	(26.5)
Others	90	96	6	6.7
TOTAL	6,231	6,249	18	0.3%

SOURCE: FAO Capacity Survey, 1974

over the period 1973-1978, means that the dissolving pulp mills are likely to shift to paper-grade pulp to maintain full production and thus provide a modest additional supply of bleached paper pulp.

Kraft pulp mills currently have about an 82% share of the world market for bleached paper-grade pulp and have supplied most of the growth in demand since World War II. However, the rate of capacity expansion for bleached kraft pulp through 1978 will drop appreciably from past trends: the 1974 FAO Capacity Survey indicates a growth rate of 4.6% per year for 1973-1978, in contrast to 10.4% per year for 1965-1972. The slowing growth of supply will be particularly critical for softwood pulp, where capacity will increase 24% in 1973-1978 compared with a 28% growth over the same period for hardwood kraft pulp.

Tables III- 40 and III-41, which show world bleached kraft capacity growth by region, indicate that one of the principal reasons for the slowing trend is a comparatively slow rate of capacity expansion in the United States, which currently accounts for about 43% of the total world supply.

A number of factors are acting to restrict pulp mill capacity expansion in the United States, and thus encourage the use of a substitute raw material. These include (1) price controls (until they were removed in mid-1974), (2) increasingly stringent and costly pollution control regulations, (3) a growing scarcity of suitable and available mill sites that have an adequate supply of wood and water, (4) concern over future operating cost inflation, and (6) increasing capital investment required to expand or build new pulp mill capacity. As a result, fewer and fewer firms have available mill sites and the financial or woodland resources needed to make major capacity expansion. Most of these constraints also apply in varying degrees to Canada and other major pulp-producing regions.

We conclude, therefore, that most pulp suppliers require higher prices and profit levels to offset these constraints and the added risks they incur before they will undertake a major expansion. In view of the three- to four-year lead time required for major capacity expansions, it is unlikely that a significant amount of expansion beyond that already planned can be achieved until after 1978.

Because of the above obstacles to major pulp and paper mill capacity expansion, most of the new capacity plans in 1978 will call for incremental additions to existing mills. As part of this incremental expansion, many pulp producers are integrating their pulp mills by adding paper machines. Thus, while paper and paperboard capacity is being expanded much slower than the historical trend, it is increasing faster than pulp capacity (Table III-42).

The chief conclusion we draw from these trends is that a relatively tight supply will be reestablished with the recovery of the world economy that is expected in 1976 and will remain tight at least through 1978.

TABLE III-40

WORLD CAPACITY TRENDS FOR SOFTWOOD BLEACHED KRAFT PULP
(000 metric tons)

Country or Region	1973	1978	Change Tonnage	 Percent
United States	8,211	9,234	1,023	12.5
Canada	5,900	6,690	790	13.4
Sweden	2,330	3,325	995	42.7
Finland	1,120	1,540	420	37.5
Other Western Europe	301	442	141	46.8
Japan	507	609	102	20.1
U.S.S.R.	450	950	500	111.1
Eastern Europe	110	381	271	246.4
Latin America	267	402	135	50.6
Other	217	425	208	95.9
TOTAL	19,413	23,998	4,585	23.6

SOURCE: FAO Capacity Survey, 1974.

TABLE III-41

WORLD CAPACITY TRENDS FOR HARDWOOD BLEACHED KRAFT PULP
(000 metric tons)

Country or Region	1973	1978	Change Tonnage	 Percent
United States	5,998	6,304	306	5.1
Japan	3,223	3,871	648	20.1
Canada	845	1,040	195	23.1
Sweden	840	875	35	4.2
Finland	680	1,060	380	55.9
Other Western Europe	1,340	1,906	566	42.2
Latin America	416	1,947	1,531	368.
Eastern Europe	109	205	96	88.
Other	249	345	96	38.6
TOTAL	13,700	17,553	3,853	28.1

SOURCE: FAO Capacity Survey, 1974

TABLE III-42

AVERAGE ANNUAL INCREASE IN WORLD PULP AND PAPER CAPACITIES
(percent)

	1963-1968	1968-1973	1973-1977
Total Paper and Paperboard	5.8	4.7	4.1
Total Paper Pulp	6.2	4.2	3.7
Printing and Writing, excl. Newsprint	6.0	5.2	4.0
Other Paper and Paperboard			4.4
Semi-Chemical Wood Pulp	7.4	4.8	4.5
Chemical Wood Pulp			3.8
Bleached Pulp			4.3

Source: FAO 1974 Capacity Survey

Table III-43 shows the major applications for bleached paper-grade pulp and our projections of each through 1980. This analysis points to an average annual growth in demand of 4% over the five-year period, compared with 6% per year in 1968-1973. Bleached kraft pulp will fill most of this increased demand, since sulfite pulp capacity will rise slowly, if at all. Thus, bleached kraft pulp demand should increase at an average of about 5% per year between 1975 and 1980.

Table III-44 compares our projections of free-world bleached kraft pulp demand with announced capacity expansion plans through 1978. It indicates an apparent world operating rate of 93% of capacity in 1973, a year in which pulp shortages began to develop. In part, these shortages were caused by a combination of labor strikes in Canada and an inventory build-up by market pulp consumers, particularly in Europe. On the other hand, 1973 conditions indicate that a 93% operating rate is near the practical maximum for the total world bleached kraft pulp industry; as this extremely tight supply/demand balance developed in 1973 and continued through most of 1974, pulp prices rose at an unprecedented rate.

Our projections indicate that the demand for all bleached paper-grade pulps will be supply-limited through 1978. These projections reflect the world recession in 1974 and 1975 as well as a general tempering of demand in response to rapidly rising pulp prices. Nevertheless, the demand projections still point to operating rates of 93-94% of capacity for 1977-1978, which is about as high as the industry can attain.

Beyond 1978, an oversupply condition is likely to develop, possibly in 1979 and 1980 as producers respond to the recent rapid rise in pulp prices and profitability. North American pulp and paper industry profits reached an all-time high in 1974. In the past, periods of rapidly rising profitability have always led to overcapacity several years later; on the other hand, the mounting obstacles to major capacity expansions militate against a serious and prolonged period of overcapacity. These obstacles suggest that if an oversupply condition does develop, it should last for no more than two years before the supply/demand balance again tightens.

3. Market Pulp Price Trends

Pulp prices were at about their lowest levels of the last decade in 1971 when world-average pulp mill operating rates were around 89% of capacity and North America, Europe, and Japan were in a business recession. There were modest price increases of $5-15 per short ton in 1972 as the economy and operating rates began to improve. Then in 1973 and 1974, prices increased at unprecedented rates as operating rates reached maximum levels. For example, in North America between the third quarters of 1972 and 1974, average contract prices for bleached softwood kraft pulp increased 100% ($160/ton) and bleached hardwood kraft pulp 165% ($200/ton). Spot prices for relatively small orders throughout the world were considerably above contract prices. These increases have

TABLE III-43

FREE-WORLD BLEACHED PAPER-GRADE PULP DEMAND, 1975-1980
(000 metric tons)

Application	1975	1980	Average Annual Growth (%)
Printing & Writing Papers (exc. Newsprint)	22,850	27,800	3.9
Tissue	4,500	5,200	2.9
Bleached Paperboard	5,[illegible]00	6,000	3.7
Newsprint	4,800	5,400	2.3
Fluffing Pulp	750	1,300	11.5
TOTAL	37,900	45,700	3.8
Kraft	32,000	40,000	4.6
Sulfite	5,900	5,700	-0.7

Source: FAO Capacity Survey, 1974

TABLE III- 44

FREE-WORLD BLEACHED KRAFT PULP DEMAND/CAPACITY, 1971-1978
(million metric tons, except as noted)

	Demand	Capacity	Apparent Operating Rate (%)
1971	25.8	28.7	89.7
1972	27.9	30.5	91.4
Projected			
1973	30.1	32.4	92.9
1974	31.5	34.3	92.0
1975	32.0	35.8	89.0
1976	34.0	37.5	91.0
1977	37.0	39.6	93.0
1978	38.5	41.1	94.0

Source: FAO Capacity Survey, 1974

allowed the producers to cover the accumulated cost inflation they previously were unable to pass on and brought their 1974 profits to a record high level.

In view of the tight supply/demand balance which we foresee for bleached paper-grade pulps through 1978, there is little question that prices will continue to escalate, but it is more difficult to predict how much. The rate of cost inflation is the most critical factor here. The predicted high mill operating rate indicates that existing mills should increase their profit margins after passing on all of their operating cost inflation. Because of the current rapid inflation of capital costs and high interest rates, the projected cost of new mills now determines the prices producers must be assured of getting before making an expansion commitment. We conclude, therefore, that bleached market pulp prices will rise faster than cost inflation in the pulp industry and that profit margins on pulp will increase in 1976-1978.

Expansion decisions that have not yet been made will strongly influence the world supply/demand balance for market pulp and thus the prices that will be charged for it. For the reasons previously cited, market pulp should continue to be in short supply; however, in the unlikely event that production capacity were to be greatly expanded over a short period, prices would inevitably drop and the prospects for increased use of secondary fiber would become less favorable. On the other hand, any price erosion that does occur is likely to be short-lived, because of the increasing constraints to making major capacity expansions in any of the bleached chemical pulps.

4. Factors Affecting Increased Waste Paper Utilization

This analysis indicates that market pulp will be in short supply worldwide. The major conclusions that can be drawn are that its selling price will increase substantially and that nonintegrated manufacturers will seek an alternative raw material. To the extent that waste paper provides a more economical source of fiber and meets the end-use product requirements, the worldwide shortage of virgin market pulp will serve to stimulate the use of waste paper.

K. SUMMARY

This section summarizes the industry structure and market characteristics that influence the choice between virgin and secondary fiber raw materials. (Technical considerations are discussed in Section VIII, and economic comparisons are given in Section IX.)

Historically, the vertical integration of larger producers from the production of pulpwood through converting operations has limited the use of secondary fiber in products where it competes directly with virgin fiber. Vertical integration of paper producers to other forest products industries and woodlands operations establishes a minimum base level of virgin fiber use which would always be economically preferable to secondary fiber pulping. A significant portion of the virgin fiber used by the paper industry comes from the residues from other forest products industries; this is economically and environmentally desirable under any circumstances, but it is particularly economical under conditions of corporate integration that permit consolidation of physical facilities.

Forward integration of paper production to converting operations and other end-use applications is another important aspect of overall industry structure. In the containerboard and newsprint categories, particularly, this integration has limited the market available to independent paper producers and specifically restricted the marketing of secondary fiber products by manufacturers who do not have the benefit of forward integration. To the extent that forward integration to consumers and vertical integration to woodlands exist within the same corporation, paper product applications have been linked directly to forest resources, and there has been limited opportunity for independent mills that use secondary fiber to penetrate this structure. For reasons that have been described both in this section and elsewhere in the report, we do not believe the historical constraints on secondary fiber usage imposed by vertical and forward integration will continue.

Historical and current market patterns and the high capital cost of new, grassroots virgin fiber pulping facilities favor incremental capacity expansion. This kind of expansion has several advantages:

- It minimizes total capital requirements at any given time (although it does not necessarily minimize unit capital costs per ton of new production capacity).
- It protects producers from cycles of oversupply and falling prices; these have plagued the paper industry in the past, and the industry is obviously anxious to avoid them during the present period of acceptable prices and profits.
- It provides an opportunity for waste paper to supply the incremental fiber requirements, since producers usually find it more feasible to add papermaking capacity than to add virgin fiber pulping capacity.

The factors that discourage overexpansion also contribute to the reduced availability and high price of market pulp. This world-wide condition creates a demand for pulp-substitute grades of waste paper, which can encourage growth in both domestic reuse and exports.

Historical growth patterns and changes in the paper industry have resulted in a concentration of small, nonintegrated mills in the Northeast and North Central regions of the country. These mills have not shared in the recent increases in paper industry profitability. Since they depend on market pulp as a fiber source, their raw material costs have increased more rapidly than their product prices. The reduced availability of market pulp will maintain, or even aggravate, this condition. However, the demand for market pulp by nonintegrated mills can encourage growth in the use of pulp-substitute grades of waste paper.

In many instances, smaller and older integrated facilities may have viable papermaking capacity integrated to less economically or ecologically viable pulping capacity. This is especially true in the case of small groundwood and semi-chemical pulp mills. An alternative source of fiber, such as waste paper, can encourage the maintenance of papermaking capacity despite the necessity for pulp mill closures.

As the prices of paper products rise, users are encouraged to accept lower quality standards rather than pay more. This condition could cause the demand for secondary fiber products to grow faster than that for virgin fiber products, since secondary fiber is often preferable for products where quality is not critical. Social changes which have removed the stigma once associated with recycled products and which now encourage reuse can also contribute to increased demand, or at least tolerance, for secondary fiber products.

Table III-45 summarizes the consumption and production patterns for paper products for 1973, 1977, and 1983. In the containerboard and groundwood groups, recycled products are shown separately for 1973 and 1977, since this represents existing or announced capacity; for 1983, however, we have indicated only the total demand, as these products are competitive and can be made from either virgin or secondary fiber. The total demand is susceptible to penetration by waste paper products, within the constraints of competitive economics and existing industry characteristics.

Table III-46, which summarizes the location and number of pulp and paper mills by major manufacturing process, points up the large number of establishments in the Northeast and North Central regions.

Table III-47 summarizes by geographic region the number of mills that produce each of the seven functional product groups used in this analysis. The number of mills that are integrated with the on-site manufacture of virgin pulp is listed under "I"; the nonintegrated ("N/I") mills rely exclusively on market pulp or a combination of market pulp and recycled fiber. (Note that the total number of mills is greater than that previously indicated, for the reason given in the footnote.) In addition to regional differences within each functional group, this table clearly shows the predominant role of nonintegrated mills in the production of tissue, folding boxboard, and industrial packaging.

TABLE III-45

PAPER AND PAPERBOARD -- PROJECTED U.S. DEMAND AND PRODUCTION

Functional Group and Grade	1973 Production	1973 Consumption	1977 Production	1977 Consumption	1983 Production	1983 Consumption
CONTAINERBOARD	19,394	17,728	22,045	20,040	27,500	25,000
Unbleached Kraft Paperboard						
Linerboard	12,986	11,340	14,660	12,680	18,980	16,510
Other Unbl. Kraft board	574	574	640	640	800	800
Recycled Linerboard	284	284	550	550	a	a
Corrugating Medium-Semi-chem.	4,322	4,302	4,625	4,600	7,370	7,340
Recycled	981	981	1,290	1,290		
Container Chipboard	247	247	280	280	350	350
GROUNDWOOD PAPER	4,874	12,286	5,300	13,600	6,100	15,800
Newsprint	3,413	10,726	3,800	11,900	4,400	13,820
Virgin	3,103	10,416	3,340	11,440	4,400	13,820
Recycled	310	310	460	460		
Uncoated Groundwood Paper	1,461	1,560	1,500	1,700	1,700	1,980
TISSUE AND OTHER MACHINE CREPED PAPER	3,983	3,983	4,470	4,470	5,200	5,200
Sanitary Tissue	3,735	3,735	4,200	4,200	4,880	4,880
Non-Sanitary Tissue	248	248	270	270	320	320
FOLDING BOXBOARD	7,674	7,324	8,270	7,880	9,450	9,000
Bleached Paperboard	3,920	3,655	4,260	3,960	4,870	4,520
Folding Recycled Paperboard	2,763	2,678	2,990	2,900	3,410	3,310
Set-up Recycled Paperboard	465	465	450	450	520	520
Other non-bending Combination Board	526	526	570	570	650	650
PRINTING, WRITING AND RELATED	11,822	11,773	13,590	13,550	16,850	16,800
Coated Printing & Conv. Paper	3,846	3,766	4,410	4,330	5,470	5,370
Uncoated Book, Chemical Writing & Thin	6,719	6,750	7,860	7,900	9,740	9,790
Cotton Fiber Writing Papers	124	124	120	120	150	150
Solid Bleached Bristols	1,133	1,133	1,200	1,200	1,490	1,490

TABLE III-45 (Cont'd)

PAPER AND PAPERBOARD -- PROJECTED U.S. DEMAND AND PRODUCTION

Functional Group and Grade	1973		1977		1983	
	Production	Consumption	Production	Consumption	Production	Consumption
INDUSTRIAL PACKAGING, CONV. & MISC.	7,373	7,268	7,980	8,150	9,500	9,700
Unbleached Kraft Paper	4,011	4,025	4,200	4,400	5,000	5,240
Other Packaging Paper	1,258	1,320	1,280	1,400	1,530	1,670
Special Industrial Paper	564	478	700	600	830	710
Special Recycled Packaged Paperboard	1,540	1,445	1,800	1,750	2,140	2,080
CONSTRUCTION PAPER AND BOARD	6,608	6,608	7,560	7,560	9,300	9,300
Construction Paper	1,812	1,812	2,060	2,060	2,540	2,540
Hard Pressed Board	2,087	2,087	2,400	2,400	2,950	2,950
Insulating Board	1,659	1,659	2,000	2,000	2,460	2,460
Gypsum Wallboard Facing	1,050	1,050	1,100	1,100	1,350	1,350
TOTAL, ALL GRADES	61,700	67,000	69,000	75,400	83,900	90,800

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a. Included with virgin linerboard

NOTE: Differences between production and consumption indicate import or export of product.

SOURCE: 1973 Production/Consumption, U.S. Department of Commerce; 1977 & 1983 projections, A. D. Little, Inc. estimates.

TABLE III-46

SUMMARY: NUMBER OF PULP AND PAPER MILLS BY PULP MANUFACTURING PROCESS

Region, State	Companies[a]	Establishments (incl. HQ units)	Paper Mills[b]	Pulp Mills (Total)	Groundwood	Other Mechanical[c]	Semichemical	Sulphite	Kraft	Miscellaneous[d]
UNITED STATES	412	953	761	411	64	71	45	32	119	80
NEW ENGLAND		146	119	43	13	2	2	3	7	16
Maine	21	26	23	21	12	–	–	3	6	–
New Hampshire	18	22	19	5	–	–	2	–	1	2
Vermont	10	10	10	2	1	–	–	–	–	1
Massachusetts	47	59	50	12	–	–	–	–	–	12
Rhode Island	2	2	1	1	–	1	–	–	–	–
Connecticut	22	27	16	2	–	1	–	–	–	1
MIDDLE ATLANTIC		213	156	39	6	9	2	1	4	16
New York	81	107	68	19	6	3	–	1	1	8
New Jersey	32	44	35	8	–	3	–	–	–	5
Pennsylvania	54	62	53	12	–	3	2	1	3	3
EAST NORTH CENTRAL		212	173	75	12	12	9	10	7	25
Ohio	41	53	43	12	–	3	2	–	1	6
Indiana	15	17	16	2	–	–	1	–	–	1
Illinois	30	36	24	10	1	5	1	–	–	3
Michigan	38	46	39	12	2	2	3	–	2	3
Wisconsin	42	60	51	39	9	2	2	10	4	12

TABLE III-46 (Continued)

SUMMARY: NUMBER OF PULP AND PAPER MILLS BY PULP MANUFACTURING PROCESS

Region, State	Companies[a]	Establishments (incl. HQ units)	Paper Mills[b]	Pulp Mills (Total)	Groundwood	Other Mechanical[c]	Semichemical	Sulphite	Kraft	Miscellaneous[d]
WEST NORTH CENTRAL		31	25	18	5	6	2	1	2	2
Minnesota	12	16	12	13	5	3	1	1	2	1
Iowa	3	3	3	2	-	1	1	-	-	-
Missouri	9	9	7	3	-	2	-	-	-	1
North Dakota	-	-	-	-	-	-	-	-	-	-
South Dakota	-	-	-	-	-	-	-	-	-	-
Nebraska	-	-	-	-	-	-	-	-	-	-
Kansas	3	3	3	-	-	-	-	-	-	-
SOUTH ATLANTIC		108	91	70	4	13	12	1	33	5
Delaware	5	7	6	2	-	-	-	-	-	2
Maryland	7	7	5	2	-	1	-	-	1	-
District of Columbia	1	1	-	-	-	-	-	-	-	-
Virginia	17	17	15	13	1	2	5	-	4	1
West Virginia	3	3	3	1	-	-	-	-	-	1
North Carolina	17	20	18	13	-	3	2	-	5	3
South Carolina	10	10	10	10	2	2	2	-	4	-
Georgia	19	23	20	17	1	3	2	-	11	-
Florida	16	20	14	12	-	2	1	1	8	-
EAST SOUTH CENTRAL		53	47	42	6	6	6	-	21	3
Kentucky	5	5	3	3	-	-	1	-	2	-
Tennessee	15	18	16	12	2	2	3	-	2	3
Alabama	17	19	18	19	3	1	2	-	13	-
Mississippi	8	11	10	8	1	3	-	-	4	-

TABLE III-46 (Continued)

SUMMARY: NUMBER OF PULP AND PAPER MILLS BY PULP MANUFACTURING PROCESS

Region, State	Companies[a]	Establishments (incl HQ units)	Paper Mills[b]	Pulp Mills (Total)	Groundwood	Other Mechanical[c]	Semichemical	Sulphite	Kraft	Miscellaneous[d]
WEST SOUTH CENTRAL		59	55	47	6	9	5	-	24	3
Arkansas	10	12	11	9	1	2	-	-	6	-
Louisiana	18	21	20	21	2	2	4	-	11	2
Oklahoma	5	7	6	5	-	2	1	-	1	1
Texas	15	19	18	12	3	3	-	-	6	-
MOUNTAIN		9	7	5	1	-	-	-	3	1
Montana	1	1	1	1	-	-	-	-	1	-
Idaho	2	2	2	1	-	-	-	-	1	-
Wyoming	-	-	-	-	-	-	-	-	-	-
Colorado	2	2	1	-	-	-	-	-	-	-
New Mexico	1	1	1	-	-	-	-	-	-	-
Arizona	2	3	2	3	1	-	-	-	1	1
Nevada	-	-	-	-	-	-	-	-	-	-
PACIFIC		122	88	71	11	14	7	15	18	7
Washington	19	30	19	27	5	2	3	9	7	1
Oregon	24	35	27	27	6	6	3	4	7	1
California	39	53	41	15	-	6	1	-	4	4
Alaska	2	2	-	2	-	-	-	2	-	-
Puerto Rico	2	2	1	1	-	-	-	-	-	1

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[a] Subsidiaries and autonomous divisions of parent companies are counted as separate units. Total reflects elimination of duplication of names in more than one state.

[b] Includes mills manufacturing paper and/or paperboard, regardless of the number of paper machines, and regardless of whether or not one or more pulp mills are located at the site.

[c] Includes steam and hot water defibrated, exploded, shredded, cold soda, and chemi-mechanical wood pulp mills.

[d] Includes deinking, rag, soda, rope, flax, bagasse, and cotton linters pulp mills.

SOURCE: Lockwood's Directory 1974

TABLE III-47

NUMBER OF INTEGRATED AND NONINTEGRATED PAPER MILLS BY FUNCTIONAL GROUP

Region	Containerboard			Groundwood			Tissue			Folding Boxboard			Printing, Writing, etc.			Industrial Packaging			Construction Paperboard			Subtotal		
	I	N/I	T	I	N/I	T	I	N/I	T	I	N/I	T	I	N/I	T	I	N/I	T	I	N/I	T	I	N/I	T
New England	3	8	11	8	1	9	9	13	22	-	12	12	11	20	31	4	29	33	2	10	12	37	93	130
Mid-Atlantic	1	18	19	3	-	3	5	20	25	1	19	20	9	16	25	3	26	29	11	18	29	33	117	150
East North Central	10	25	35	3	-	3	8	6	14	1	21	22	23	18	41	4	25	29	16	9	25	65	104	169
West North Central	2	2	4	3	-	3	-	-	-	-	1	1	3	-	3	1	1	2	5	7	12	14	11	25
South Atlantic	30	4	34	2	-	2	3	4	7	10	8	18	4	2	6	9	9	18	11	7	18	69	34	103
East So. Central	10	2	12	2	-	2	2	1	3	5	1	6	4	1	5	3	6	9	7	4	11	33	15	48
West So. Central	10	3	13	4	-	4	1	-	1	4	1	5	4	-	4	8	2	10	8	13	21	39	19	58
West	14	10	24	8	-	8	5	12	17	3	8	11	6	3	9	9	7	16	10	11	21	55	51	106
Subtotal	80	72	152	33	1	34	33	56	89	24	71	95	64	60	124	41	105	146	70	79	149	345	444	789

I = integrated; N/I = nonintegrated; T = Total

Note: A mill may be counted more than once if it is classified into more than one functional group

Source: Data from Lockwood's Directory (1974), reaggregated by Arthur D. Little, Inc., into functional groups.

IV. WOOD RESOURCE CONSIDERATIONS

This section deals with the cost and availability of pulpwood. It is intended to complement Sections VI and VII, which give similar information for waste paper, and thereby provide perspective on the competitive positions of these alternative raw materials for pulp and paper manufacture. Other sources, notably the U. S. Department of Agriculture Report No. 20 entitled "The Outlook for Timber in the United States" (October 1973) provide a detailed analysis of the potential wood supply.

A. BACKGROUND AND APPROACH

Invariably, the most important cost consideration in the manufacture of pulp and paper is the cost of wood; thus, a clear understanding of wood cost and availability is critical to the assessment of the competitive opportunity for waste paper as an alternative raw material.

Pulpwood is obtained as a by-product from the manufacture of primary timber products (lumber and plywood) and directly from standing timber. While the percentage of pulpwood obtained from manufacturing plant and logging residue has increased substantially over the past 20 years, the industry still relies on a substantial amount of pulpwood from standing timber (roundwood) to meet its wood requirements. In general, roundwood is obtained from smaller sizes and lower grades of timber than those used for primary timber products; however, a substantial volume of timber suitable for lumber is also consumed in the production of paper and paperboard. In many cases, the latter comes from areas in which saw timber is uneconomical to harvest--i.e., where saw-timber trees are scattered, or where pulpwood is harvested by small producers from small tracts. Combined, these sources of timber constitute a considerable volume of saw timber used in pulp manufacture. Thus, regardless if pulpwood is obtained as a by-product from the manufacture of primary timber products or directly from standing timber, its cost and availability are tied intimately to the demand for primary timber products.

The analysis of market demand and growth trends of these primary wood products is beyond the scope of this study. The Forest Service study previously cited deals with the broad and complex interrelationship of overall demand and supply for the various timber products. It concludes that while the domestic supply is adequate through the studied period of this report (even at the 1970 level of forest management), more intensive forest management is required to meet the total U.S. timber requirement beyond 1985.

Accordingly, this section provides a brief summary of the Forest Service report with specific emphasis on how the overall timber resource affects the cost and availability of pulpwood. It examines the ownership patterns and regional supply/demand relationships for timber to shed light on its possible cost and competitive position with respect to secondary fiber. Appendix B-1 lists some pertinent reports, publications, and recent articles related to wood resources.

Our analysis is based upon current forestry management methods and resultant timberland yields; subsequently, data are given on the timber growth that could be obtained with the most modern forest management techniques.

In analyzing wood cost, we have supplemented published data with information from various public agencies and associations and from private communications with key industry contacts. All costs are expressed in second-quarter 1974 dollars.

Figure IV-1 shows the major sections and regions used in the presentation of the data. The regions that make up the sections have been reaggregated from the traditional grouping (North, South, Rocky Mountain, and West) to the Northeast, North Central, South, and West sections in order that the wood resource data would be based on the same area categories used in other parts of this study.

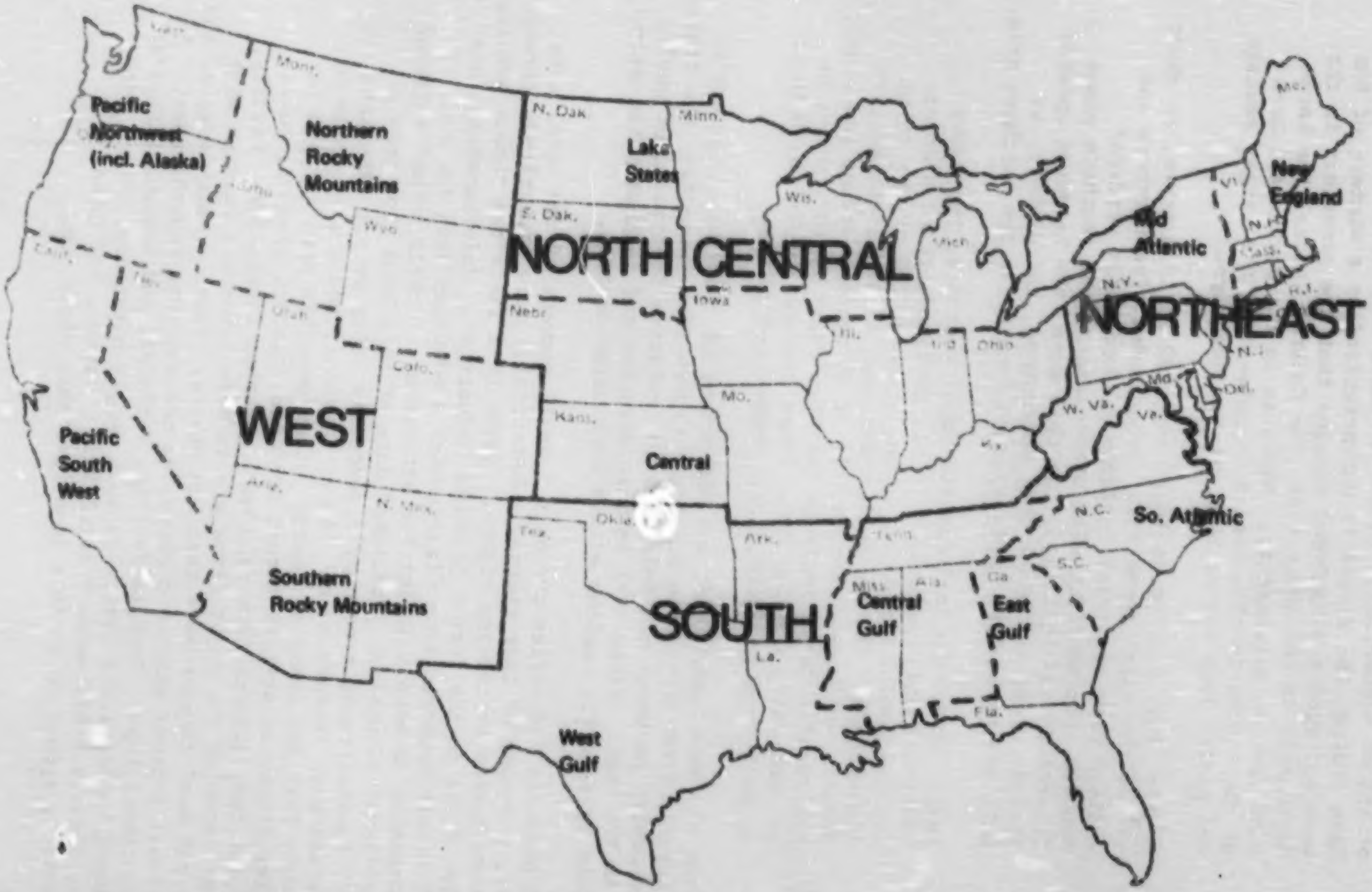
Another change made in the original Forest Service data was to convert wood volumes reported in cubic feet to cunits (hundreds of cubic feet). This was done so that the inventory and timber growth would be expressed in the terms commonly used by pulp and paper mills in reporting their wood consumption data. Where original data was reported in cords and converted to cunits, it was done on the basis of 83 cubic feet per cord for softwood and 79 cubic feet for hardwood.

B. OWNERSHIP PATTERNS OF COMMERCIAL TIMBER AND TIMBERLAND

Commercial timberland is defined as that available and suitable for growing continuous crops of sawlogs or other industrial timber products at a rate of at least 20 cubic feet per acre per year. In 1970, 500 million acres, or about 22% of the total land area of the United States, was classified as commercial forest. This figure has not changed significantly in the past 20 years.

The following is a general discussion of the timberland characteristics of the four major geographic sections considered in this analysis.

(1) Northeast: This section includes some 82 million acres, or about 16% of the total timberland area. The timber in this region is about a 50/50 mixture of northern softwood--spruce, pine, tamarack, cedar, etc.--and hardwood species--oak, maple, poplar, aspen, paper birch, etc. Most of the timber is of pole size; the larger, sawlog-class timber was removed many years ago.


Pacific
Northwest
(incl. Alaska)
Northern
Rocky
Mountains
Mont.
Idaho
Wyo.
Calif.
Nev.
Utah
Colo.
Ariz.
N. Mex.
WEST
Pacific
South
West
Southern
Rocky Mountains
N. Dak.
Lake
States
Minn.
S. Dak.
Wis.
Mich.
NORTH CENTRAL
Nebr.
Iowa
Ill.
Ind.
Ohio
Kans.
Mo.
Central
Ky.
Okla.
Tex.
Ark.
Tenn.
SOUTH
La.
Miss.
Ala.
Central
Gulf
Ga.
East
Gulf
Fla.
S.C.
N.C.
So. Atlantic
Va.
W. Va.
Md.
Del.
N.J.
N.Y.
Mid
Atlantic
Vt.
N.H.
Mass.
R.I.
Me.
New
England
NORTHEAST
West
Gulf

Source: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973.

FIGURE IV-1 GEOGRAPHIC SECTIONS AND REGIONS OF THE UNITED STATES USED IN THIS REPORT

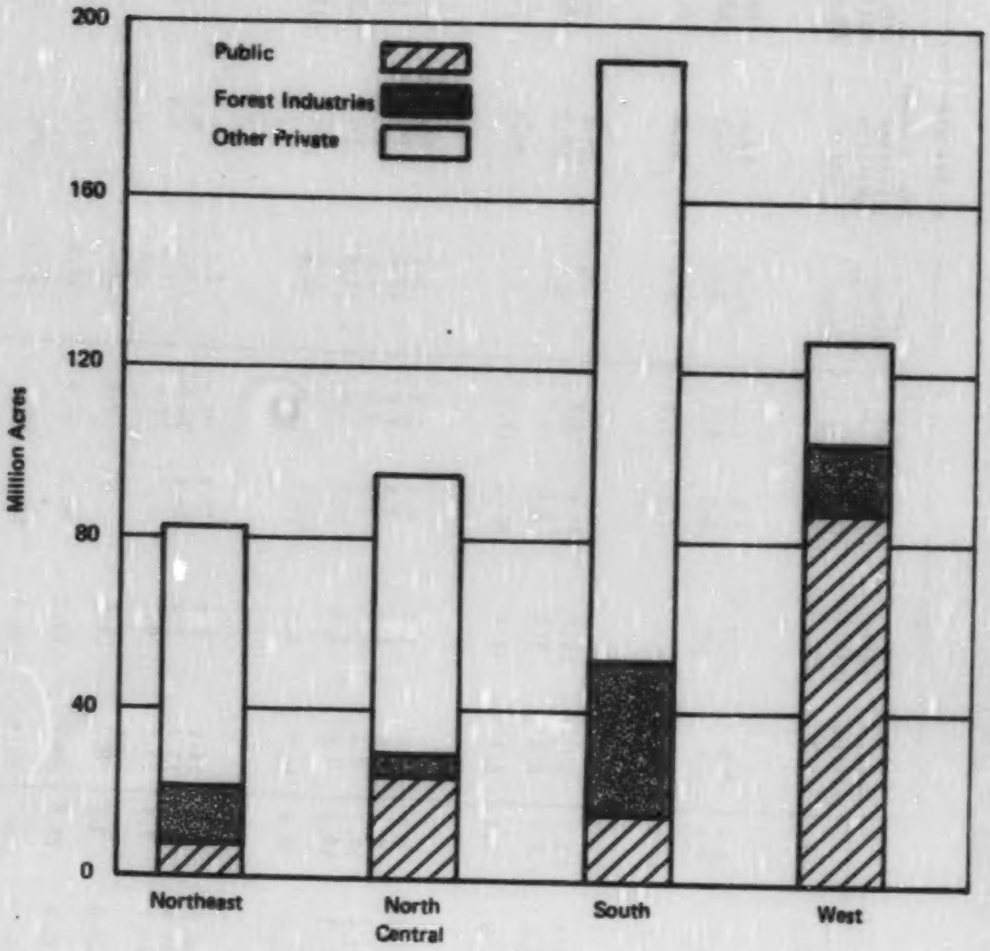
(2) North Central: This section includes some 96 million acres, or 19% of timberland. In the northern tier of states (the Lake States) the forest is characterized by a mixture of the same softwood and hardwood species that are prevalent in the Northeast; in the lower tier (the Central States) the hardwood species predominate. Also, as in the Northeast, much of the timber in this region is pole-size, the larger sawlogs and peeler logs having been removed long ago.

(3) South: This section includes some 192 million acres, or about 39% of the total commercial timberlands. The northern and western tier of states includes predominantly hardwood species, the southern tier predominantly the southern pines (shortleaf and loblolly). In this area, the hardwood species include sweet and black gum, cottonwood, and hickory, as well as the oak and maple species located in the northern area.

(4) West: This area includes two major sections, the Rocky Mountains and the Pacific Coast; combined, these sections include some 130 million acres, or about 26% of the total timberlands. The Rocky Mountain area includes the Western Forest, which consists chiefly of softwoods (spruce and pine); the Pacific Coast includes the West Coast Forest, which is predominantly Douglas fir. These regions supply the bulk of primary wood products, i.e., lumber and plywood.

Ownership of these timberlands and the volume of timber on them varies significantly from section to section. Figure IV-2 summarizes the timberland ownership patterns and indicates the relative importance of public lands in the West. Table IV-1 is more detailed and indicates the ownership data by specific regions within each major section.

Forest products industries own only a small segment of the total area; however, a number of them control substantially more timberlands through long-term leases or cutting rights. Table IV-2 lists the timber holdings of major firms in the forest products industries. Unfortunately, one cannot simply compare these figures with production data for each of the companies to make a definitive assessment of their actual pulpwood supply/demand situation. Published data of this kind give only a primary indication of a company's resources; they do not take into consideration such factors as the timber inventory and timber class on the lands that are owned or leased, other possible applications for standing timber in primary forest products (lumber, plywood, poles, etc.), or the distance from pulp manufacturing facilities. Clearly, however, some of the major firms are in more favorable balance with their pulpwood requirements than are others. From our knowledge of the additional factors mentioned above, we can say that Weyerhaeuser, International Paper, Georgia Pacific, Potlatch, and Louisiana Pacific are among those with a favorable wood supply situation; other major firms, notably Fibreboard, Federal Paper Company, and Crown Zellerbach, appear to be in a less favorable situation.



Basis: January 1970
Total Timberland = 500 million acres

Sources: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973, and Arthur D. Little, Inc., calculations.

FIGURE IV–2 OWNERSHIP PATTERN OF COMMERCIAL TIMBERLANDS

TABLE IV-1

OWNERSHIP PATTERN OF COMMERCIAL TIMBERLAND, JANUARY 1970

Section, Region	Total		Public				Private			
	Million Acres	%	National Forest (Million Acres)	Other Public (Million Acres)	Total Public Million Acres	Total Public %	Forest Industry (Million Acres)	Farm & Other Private (Million Acres)	Total Private Million Acres	Total Private %
NORTHEAST										
New England	32.4	6.4	0.8	1.2	2.0	1.4	10.0	20.4	30.4	8.4
Middle Atlantic	49.7	9.9	1.4	4.4	5.8	4.3	2.5	41.4	43.9	12.1
Total Northeast	82.1	16.3	2.2	5.6	7.8	5.7	12.5	61.8	74.3	20.5
NORTH CENTRAL										
Lake States	50.8	10.2	5.9	14.7	20.6	15.1	4.4	25.8	30.2	8.3
Central	45.0	9.0	2.4	1.2	3.6	2.6	0.7	40.8	41.5	11.4
Total North Central	95.8	19.2	8.3	15.9	24.2	17.7	5.1	66.6	71.7	19.7
SOUTH										
South Atlantic	48.5	9.7	2.8	1.7	4.5	3.3	6.5	37.5	44.0	12.1
East Gulf	41.3	8.3	1.8	1.7	3.5	2.6	10.0	27.9	37.9	10.4
Central Gulf	51.5	10.3	2.3	1.7	4.0	3.0	7.4	40.0	47.4	12.9
West Gulf	51.3	10.3	3.8	1.4	5.2	3.8	11.5	34.6	46.1	12.7
Total South	192.6	38.6	10.7	6.5	17.2	12.6	35.4	140.0	175.4	48.2
WEST										
Northern Rocky Mountain	36.7	7.3	24.1	3.8	27.9	20.5	2.1	6.6	8.7	2.4
Southern Rocky Mountain	25.0	5.0	15.7	3.4	19.1	14.0	0.2	5.8	6.0	1.6
Pacific Northwest (incl. Alaska)	49.7	9.9	22.6	8.1	30.7	22.6	9.5	9.5	19.0	5.2
Pacific Southwest	18.0	3.6	8.3	1.0	9.3	7.3	2.7	6.0	8.7	2.4
Total West	129.4	25.9	70.7	16.3	87.0	63.9	14.5	27.9	42.4	11.6
TOTAL U.S. (acres)	500	100	91.9	44.2	136.1	100	67.3	296	363.8	100
(%)	100		18.4	8.8	27.2		13.5	59.3	72.8	

SOURCE: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973

TABLE IV-2

TIMBER HOLDINGS OF MAJOR FOREST PRODUCTS COMPANIES
(thousands of acres)

Company	U.S.	Canada & Elsewhere	Leases, Cutting Rights	Total Owned & Controlled
International Paper Company	6,769	1,360	15,560	23,689
Weyerhaeuser Company	5,671	48	10,723	16,442
Kimberly-Clark Corporation	1,300	N.A.	8,900	10,200
Champion-International Corporation	2,371	108[a]	4,871	7,350
Mead Corporation	939	-	5,441	6,380
Boise-Cascade Corporation	1,950	12	4,160	6,122
Georgia-Pacific Corporation	3,275	1,225[a]	1,498	5,998
St. Regis Paper Company	2,586	-	3,098	5,684
Crown Zellerbach Corporation	1,463	178	1,775	3,416
Scott Paper Company	1,836	1,096	403	3,335
Great Northern-Nekoosa Corporation	2,584	-	185	2,769
Louisiana-Pacific Corporation	580	-	1,904	2,484
Union Camp Corporation	1,450	-	150	1,600
Diamond International Corporation	1,376	5	27	1,408
Potlatch Corporation	1,300	-	65	1,365
Westvaco Corporation	1,025	75[b]	-	1,100
Masonite Corporation	492	-	51	543
Hammermill Paper Company	330	-	55	385
Total	37,297	4,107	58,866	100,270

[a] Canada and Brazil

[b] Brazil

N.A. - not available

SOURCE: Forbes Magazine, July 15, 1974

The net volume (i.e., inventory) of timber on these commercial timberlands is about 7.2 billion cunits, of which some 4.6 billion (64%) and 2.6 billion (36%) cunits are softwood and hardwood respectively. The dominance of the West as the major timber supplier is evident; it contains some 3.6 billion cunits, or fully 50% of the total U.S. timber volume. Furthermore, it contains 73% of the total supply of softwood timber (Table IV-3). Figure IV-3 summarizes timber ownership by major geographic section, and illustrates the percentage of growing stock on public and private holdings. Again, the dominant role of the West as the major timber supply is illustrated. Table IV-4 is a more detailed analysis of the ownership patterns by subsections (regions) and components of the private sector.

C. SUPPLY/DEMAND FOR TIMBER

Figure IV-4 summarizes the total removals (demand) in 1970 for all timber products by wood species in the four major geographic areas. Table IV-5 presents the same data in greater detail by subsections (regions). Note that with the exception of the West, the annual growth of timber exceeded removals.

Historically, the yield of timber per acre in all regions has been well below the potential growth. The Forest Service estimates that with more intensive forest management, annual growth in all major producing regions could be about doubled (Figure IV-5). Some companies are now using the most modern forest management practices, but it will have no substantial effect upon the supply of timber over the next decade.

Although the demand for timber products was greater in 1973--i.e., removals increased--growth still exceeded removals in all but the Western section. Furthermore, the recession of 1974 caused a sharp decline in timber demand; hence, the 1970 data provide a reasonable basis for assessing the overall fiber balance.

Pulpwood is only one end-use requirement of the annual timber harvest; in fact, it is often the byproduct of primary timber products and not the principal reason for timber removals. This is clear from an inspection of Figure IV-6, which shows pulpwood requirements in relationship to total timber growth and removals. (Total growth and removals are based on historical 1970 data; pulpwood requirements are based on recent 1973 and projected 1977 data. We used 1970 data for timber growth and removals because they are the most complete that are readily available*; however, the increased demand that occurred in 1973 does not alter the overall findings of the analysis. On the other hand, pulpwood demand data are available for 1973; hence, we used those data to show the relationship between total removals and specific pulpwood requirements.)

Figure IV-6 includes 1977 projections to show that the increase in pulpwood consumption between 1973 and 1977 will be small compared with the

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* The complete data from USDA sources are reproduced in Appendix B-2.

total growth and removal of timber. The bars that indicate pulpwood consumption are segmented to show the relative amounts of timber harvested for pulpwood purposes and the residue derived from primary lumber manufacture or logging residue. (The increased use of residue to augment supplies of pulpwood is discussed in Section V.) Table IV-6 summarizes the API data on pulpwood use in 1973 and projections to 1977.

D. PULPWOOD PRICES

1. Sources of Variation

Pulpwood may originate from any of the following sources:

- Roundwood, i.e., pole-size timber harvested specifically for pulpwood;
- Chips or other forms of waste wood produced as a by-product in the manufacture of primary timber products;
- Logging residue, i.e., pulpwood salvaged from logging operations, including slash, culls, and saplings; and
- Rotten or culled trees not suitable for the manufacture of primary timber products.

This pulpwood may be transported to the pulp mill by truck, rail, barge, river drives, etc., and in a variety of forms (short wood, long logs, chips, shavings, sawdust, etc.). All these factors--the origin of the wood, transportation method and distance, and the form of the wood--as well as other factors subsequently discussed, influence the price of delivered wood to a pulp mill.

Tables IV-7 and -8 illustrate the effect of origin, species, and form on the prices paid by various consuming mills. These data also show how delivered prices tend to be higher where the competition for pulpwood is greater. (Although the concentration of pulp mills is not evident from the tables, reference to Appendix A shows that the concentration is much greater in Washington and Oregon than in California.) The exporting of chips from the Pacific Northwest further increases the competition for wood in that area and enables those who sell it to command higher prices.

A recent survey of pulpwood costs in the Northwest has substantiated the inherent variation of pulpwood procurement practices and delivered cost to a mill.* Although the delivered price of pulpwood was found to vary over a wide range for a number of reasons, in general the survey respondents cited the following four major determinants:

(Continued on page IV-20)

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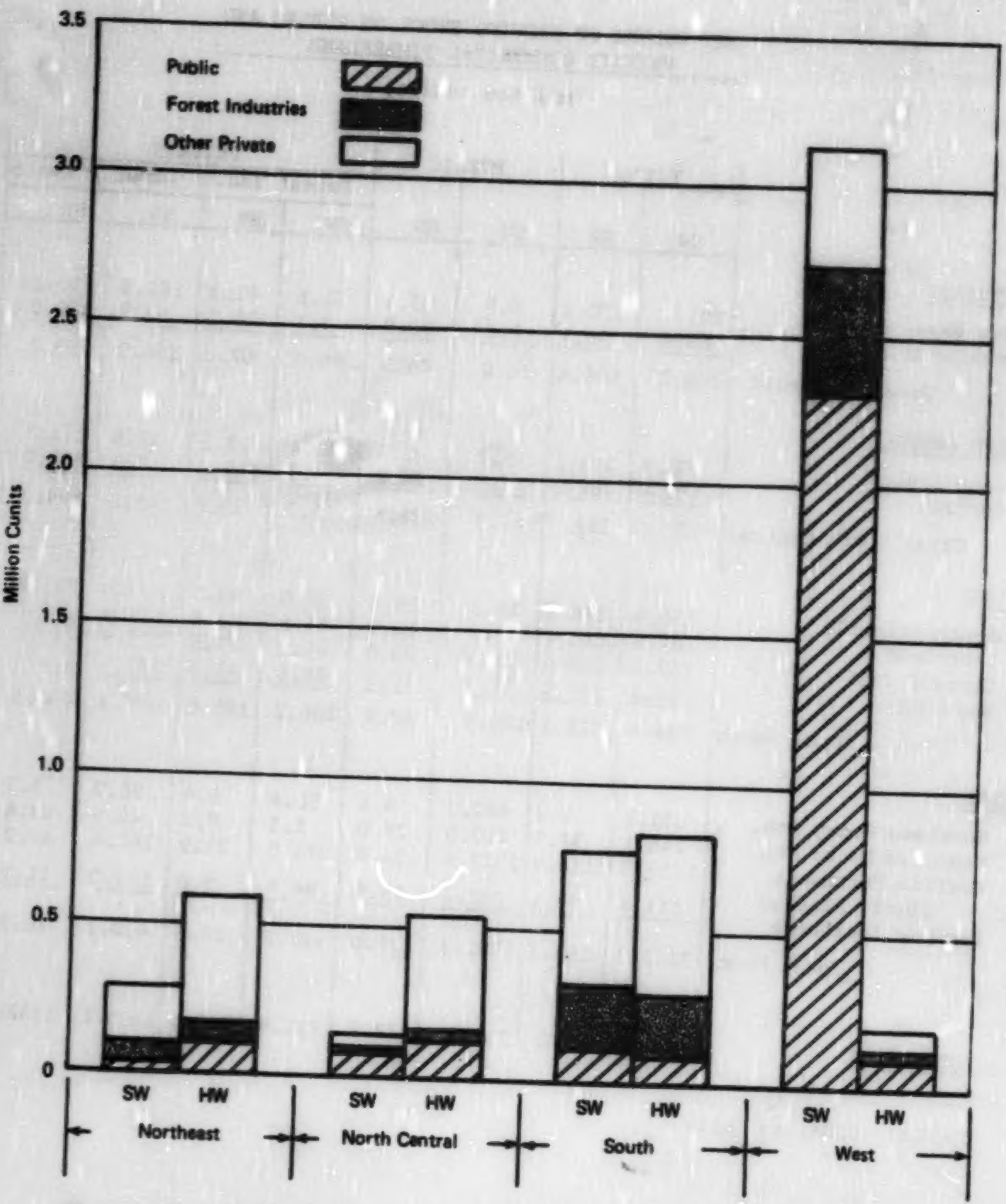
*J. W. Austin, "Price Trends in Fiberwood Used by Mills in Northwest", Pulp and Paper, March 1973, p. 63.

TABLE IV-3

NET VOLUME OF TIMBER ON COMMERCIAL TIMBERLAND BY WOOD SPECIES - JANUARY 1970

Section, Region	All Species		Softwood		Hardwood	
	MM Cunits	(%)	MM Cunits	(%)	MM Cunits	(%)
NORTHEAST						
New England	404.7	5.7	222.4	4.9	182.3	7.0
Middle Atlantic	589.4	8.2	74.7	1.6	514.7	19.8
Total Northeast	994.1	13.9	297.1	6.5	697.0	26.8
NORTH CENTRAL						
Lake States	430.0	6.0	112.4	2.5	317.5	12.2
Central	320.1	4.5	14.0	0.3	306.0	11.8
Total North Central	750.1	10.5	126.4	2.8	623.5	24.0
SOUTH						
South Atlantic	559.8	7.8	199.1	4.4	360.7	13.9
East Gulf	339.2	4.7	192.4	4.2	146.8	5.7
Central Gulf	459.9	6.4	185.5	4.1	274.5	10.6
West Gulf	486.4	6.8	226.9	5.0	259.5	10.0
Total South	1,845.4	25.8	803.8	17.7	1,041.5	40.2
WEST						
Northern Rocky Mountain	712.2	10.0	703.1	15.4	9.1	0.4
Southern Rocky Mountain	330.2	4.6	275.2	6.0	54.9	2.0
Pacific Northwest(incl.Alaska)	1,951.6	27.3	1,824.6	40.1	127.0	4.9
Pacific Southwest	561.9	7.9	521.3	11.4	40.6	1.6
Total West	3,555.9	49.8	3,324.2	73.0	231.6	8.9
TOTAL U. S.	7,145.4	100	4,551.7	100	2,593.7	100
			64% Softwood		36% Hardwood	

SOURCE: "The Outlook for Timber in the United States," FRR 20, U.S. Department of Agriculture, October 1973



Source: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973.

FIGURE IV–3 OWNERSHIP PATTERN OF GROWING STOCK ON COMMERCIAL TIMBERLANDS, 1970

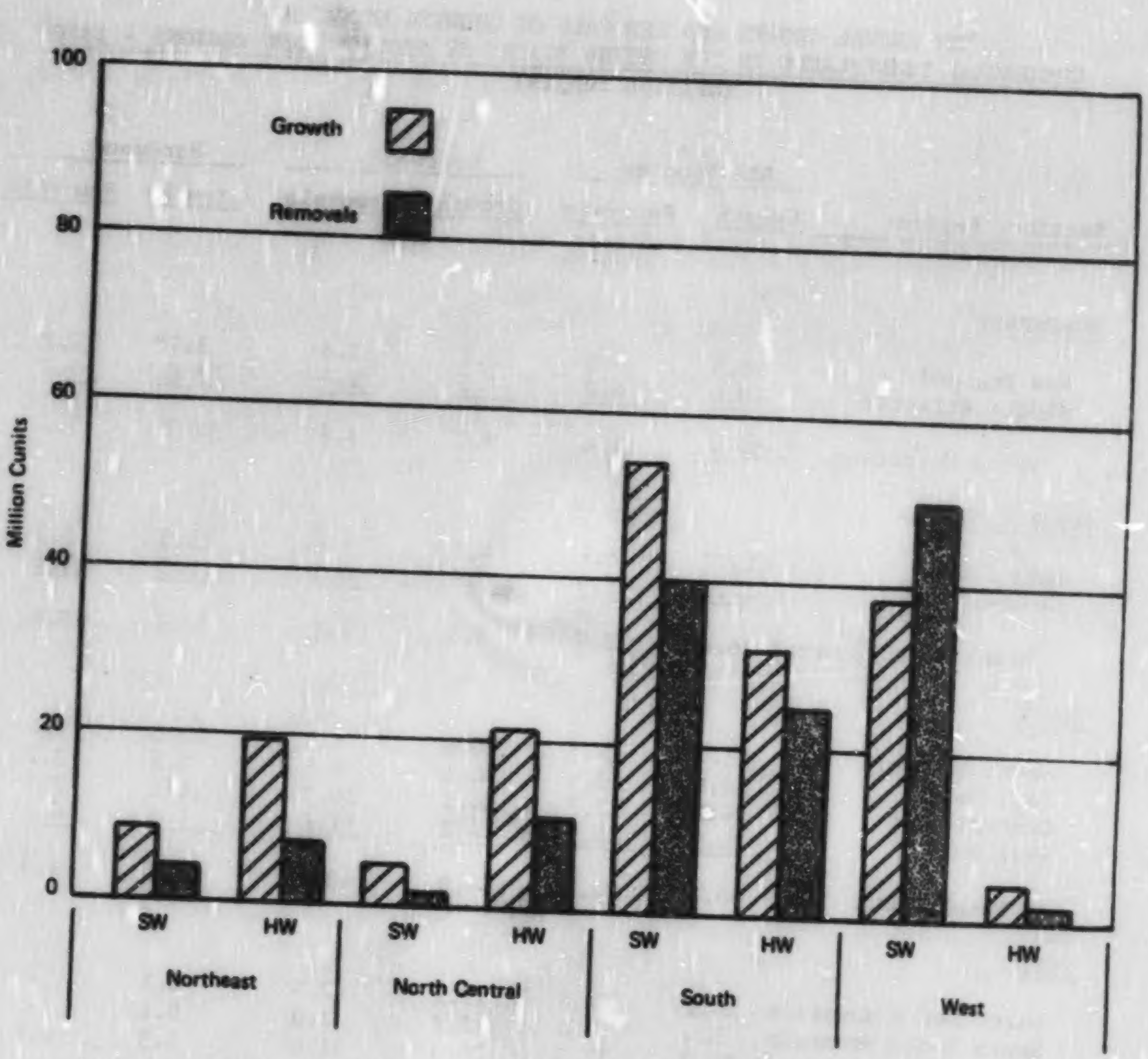
TABLE IV-4

NET VOLUME OF GROWING STOCK ON PUBLIC AND PRIVATE COMMERCIAL TIMBERLAND

(million cunits)

	TOTAL		PUBLIC		PRIVATE			
					Forest Ind.		Other Private	
	SW	HW	SW	HW	SW	HW	SW	HW
NORTHEAST								
New England	201.9	150.2	8.8	15.4	91.6	41.6	101.5	93.2
Middle Atlantic	66.9	456.4	9.2	70.9	5.1	25.5	52.7	360.0
Total Northeast	268.8	606.6	18.0	86.3	96.7	67.1	154.2	453.2
NORTH CENTRAL								
Lake States	108.9	291.8	55.7	102.3	15.4	28.2	37.8	161.3
Central	13.4	267.2	5.6	24.2	0.3	5.0	7.5	238.0
Total North Central	122.3	559	61.3	126.5	15.7	33.2	45.3	399.3
SOUTH								
South Atlantic	190.9	284.6	19.5	29.8	32.0	33.5	139.5	221.2
East Gulf	187.4	118.4	23.8	10.9	44.6	23.8	119.0	[illegible]3.7
Central Gulf	182.2	220.6	25.3	20.0	41.0	27.5	115.9	[illegible]2
West Gulf	223.5	187.5	31.9	20.2	88.6	41.0	102.9	12[illegible].4
Total South	784.0	811.1	100.5	80.9	206.2	125.8	477.3	604.5
WEST								
Northern Rocky Mtn.	631.1	7.2	482.3	3.4	50.8	0.4	98.0	3.5
Southern Rocky Mtn.	246.1	37.9	200.0	25.0	1.5	0.2	44.6	12.6
Pacific Northwest (incl. Alaska)	1754.9	114.9	1317.6	34.8	274.0	32.9	163.4	47.2
Pacific Southwest	511.6	33.3	302.4	15.8	86.9	5.8	122.3	11.9
Total West	3143.7	193.3	2302.3	79.0	413.2	39.3	428.3	75.2
TOTAL U. S.	4318.7	2170	2,482.1	372.7	731.8	265.4	1105.1	1532.2

SOURCE: USDA, op. cit.



Source: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973.

FIGURE IV–4 NET ANNUAL GROWTH AND REMOVALS OF GROWING STOCK ON COMMERCIAL TIMBERLAND IN THE UNITED STATES, 1970

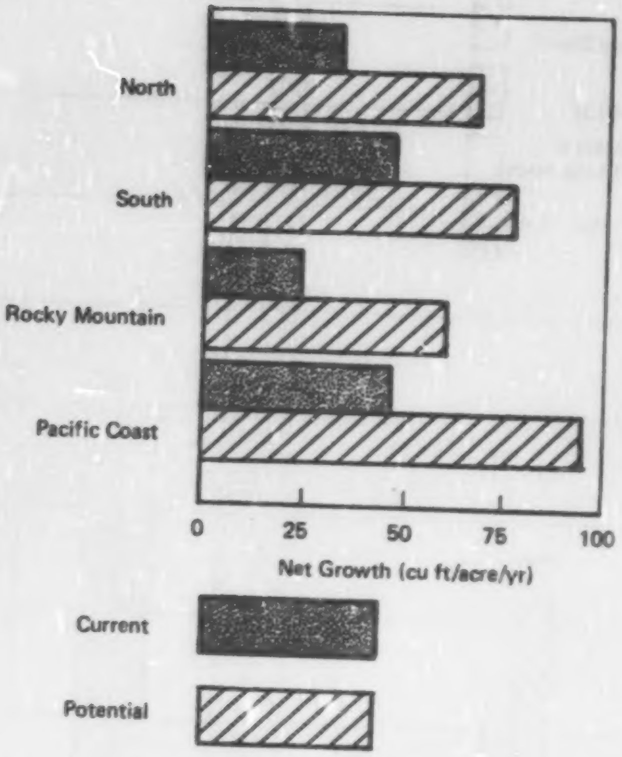
TABLE IV-5

NET ANNUAL GROWTH AND REMOVALS OF GROWING STOCK ON COMMERCIAL TIMBERLANDS IN THE UNITED STATES BY SECTIONS AND REGIONS - 1970

(million cunits)

Section, Region	All Species		Softwood		Hardwood	
	Growth	Removals	Growth	Removals	Growth	Removals
NORTHEAST						
New England	10.8	5.6	7.1	3.4	3.7	2.2
Middle Atlantic	18.0	6.0	1.9	1.0	16.0	5.0
Total Northeast	28.8	11.6	9.0	4.4	19.7	7.2
NORTH CENTRAL						
Lake States	15.7	6.8	4.2	1.6	11.5	5.2
Central	10.9	5.9	0.6	0.3	10.3	5.6
Total North Central	26.6	12.7	4.8	1.9	21.8	10.8
SOUTH						
South Atlantic	21.4	15.8	10.6	8.4	10.8	7.4
East Gulf	18.9	12.8	14.1	9.6	4.8	3.2
Central Gulf	24.2	17.7	14.1	10.2	10.1	7.5
West Gulf	21.6	18.5	15.2	11.8	6.4	6.7
Total South	86.1	64.8	54.0	40.0	32.1	24.9
WEST						
North Rocky Mountain	10.2	7.3	10.1	7.3	0.1	-
South Rocky Mountain	3.4	2.0	2.8	2.0	0.6	-
Pacific Northwest (incl. Alaska)	24.3	32.5	20.4	31.6	3.8	0.9
Pacific Southwest	6.3	9.3	5.4	9.0	0.8	0.3
Total West	44.2	51.1	38.7	49.9	5.3	1.2
TOTAL U. S.	185.6	140.3	106.7	96.2	79.0	44.1

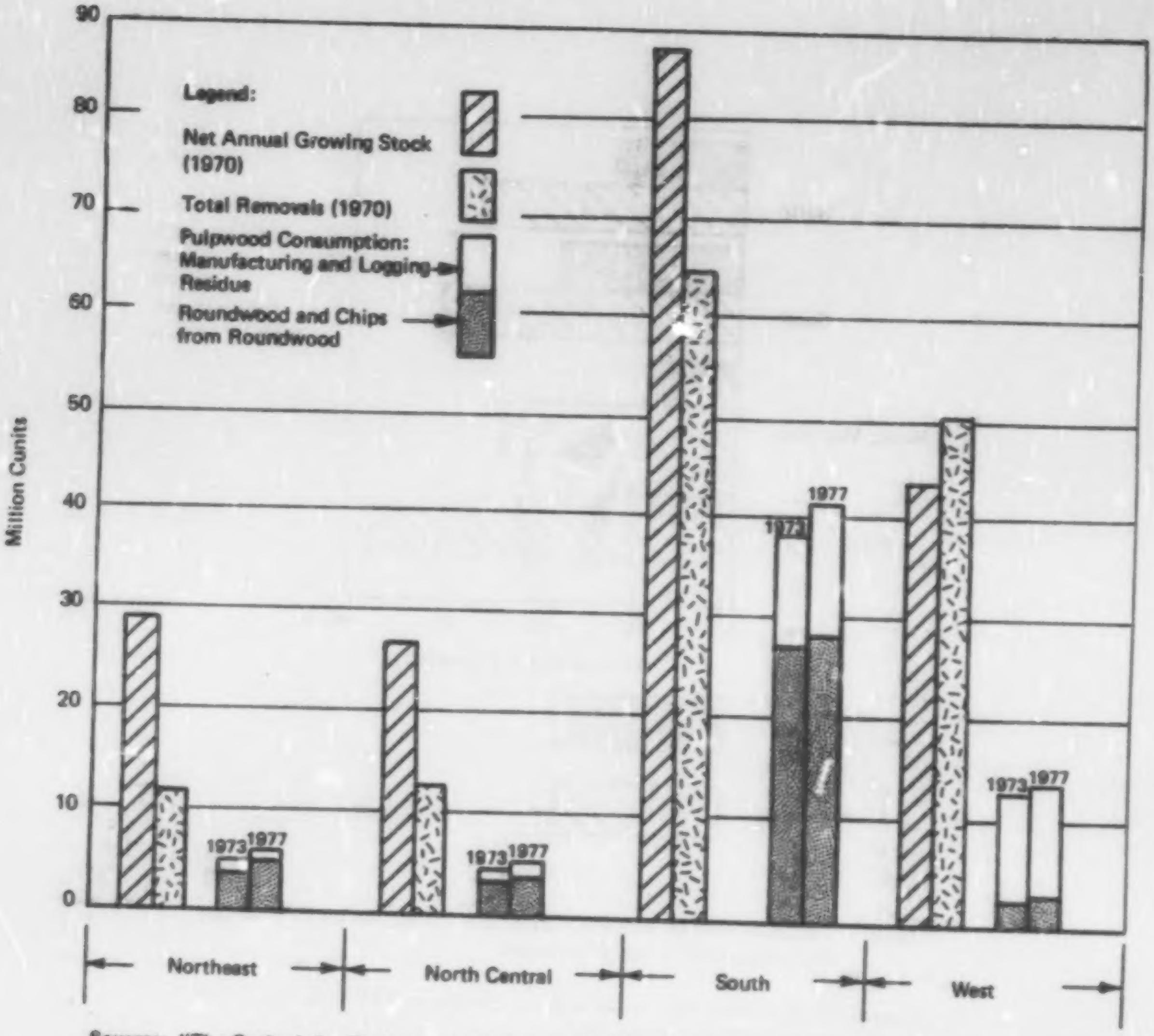
SOURCE: USDA, op. cit.



Note: The geographic sections reported by U.S. Forest Service are dissimilar from those used in this presentation.

Source: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973.

FIGURE IV–5 POTENTIAL AND CURRENT NET GROWTH PER ACRE



Sources: "The Outlook for Timber in the United States," FRR 20, U.S. Dept. of Agriculture, October 1973 (growth and removals); API Capacity Survey data (pulpwood usage)

FIGURE IV–6 TIMBER GROWTH, REMOVALS AND PULPWOOD CONSUMPTION BY MAJOR GEOGRAPHIC SECTION

TABLE IV-6

PRESENT AND PROJECTED PULPWOOD CONSUMPTION BY MAJOR GEOGRAPHIC SECTION AND REGION

(million cunits)

	Roundwood & Roundwood Chips		Manufacturing Residue		Forest Residue		Total	
Section, Region	1973	1977	1973	1977	1973	1977	1973	1977
NORTHEAST								
New England	2,972	3,499	410	559	11	11	3,393	4,069
Middle Atlantic	1,189	1,366	288	307	160	168	1,637	1,841
Total Northeast	4,161	4,865	698	866	171	179	5,030	5,910
NORTH CENTRAL								
East North Central	2,783	3,012	721	874	185	234	3,689	4,120
West North Central	654	623	280	317	17	52	951	992
Total North Central	3,437	3,635	1,001	1,191	202	286	4,640	5,112
SOUTH								
South Atlantic	13,814	13,644	4,531	6,136	287	509	18,632	20,289
East South Central	6,983	7,326	1,716	2,254	714	1,054	9,413	10,634
West South Central	6,605	7,482	2,191	2,999	1,068	1,192	9,864	11,673
Total South	27,402	28,452	8,438	11,389	2,069	2,755	37,909	42,596
WEST								
North Rocky Mountain								
South Rocky Mountain								
Pacific Northwest (incl. Alaska)	2,783	3,055	9,538	9,848	684	718	13,005	13,621
Pacific Southwest								
Total West	2,783	3,055	9,538	9,848	684	718	13,005	13,621
TOTAL U.S.	37,783	40,007	19,675	23,294	3,126	3,938	60,584	67,239

SOURCE: API Capacity Survey, 1973-1976

TABLE IV-7

FIBERWOOD PRICES BY FORM OF WOOD AND MILL TYPE
(1972 dollars per BD ton)

State and mill type	Chips		Sawdust		Shavings		Utility grade logs[2]		No. 3 saw logs	8-foot pulpwood bolts	Peeler cores	Wood flour	Lumber trim
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Avg.	Avg.	Avg.	Avg.
WASHINGTON													
Pulp													
Sulfate	19.25	12.50-27.50	7.25	6.75-8.25	--	--	16.75	12.00-22.50	22.25	--	12.00	--	--
Sulfite	20.00	15.75-24.00	7.00	3	--	--	20.25	18.25-22.50	--	--	--	--	--
Groundwood	21.25	17.50-25.50	--	--	--	--	18.75	2	22.00	17.75	16.25	--	--
Other	21.00	18.75-24.00	--	--	--	--	20.25	18.75-21.00	--	--	--	--	--
Average[4]	20.00	12.50-27.50	7.25	6.75-8.25	--	--	17.25	12.00-22.50	21.25	17.75	13.00	--	--
Board	--	--	--	--	5.75	3	--	--	--	--	--	--	--
OREGON													
Pulp													
Sulfate	18.00	15.00-23.25	5.75	4.75-6.75	--	--	17.00	15.75-18.25	--	--	--	--	--
Sulfite	16.25	12.00-18.75	5.75	4.25-6.50	--	--	23.00	3	--	--	--	--	--
Groundwood	17.00	12.00-20.75	6.50	3	--	--	18.50	15.75-23.00	20.75	--	--	--	--
Average[4]	17.25	12.00-23.25	5.75	4.25-6.75	--	--	18.50	15.75-23.00	20.75	--	--	--	--
Board													
Particleboard	7.75	3	4.75	3.00-7.00	6.75	4.26-10.00	--	--	--	--	--	--	5.75
Hardboard and insulation board	14.50	13.50-18.00	4.75	1.50-6.50	7.25	5.50-10.00	12.50	3	--	--	--	--	--
Average	13.50	7.75-18.00	5.00	1.50-7.00	6.50	4.25-10.00	12.50	3	--	--	--	--	5.75
CALIFORNIA													
Pulp													
Sulfate	14.50	12.00-15.75	5.00	2	--	--	14.00	13.00-18.50	--	--	--	--	--
Groundwood	15.00	12.00-15.75	--	--	--	--	14.00	13.00-18.50	--	--	--	--	--
Average[4]	14.50	12.00-15.75	5.00	3	--	--	14.00	13.00-18.50	--	--	--	--	--
Board	9.00	5.50-13.00	3.00	3	5.00	3.50-9.25	--	--	--	--	16.00	--	--
Felt	15.00	10.00-18.50	--	--	--	--	--	--	--	--	--	23.50	6.50

[1] Rounded to nearest $0.25; prices f.o.b. consuming mill.
[2] Converted from price per MBF either by the firm or using the factor: 2 BDT per MBF.
[3] Range $1 or less.
[4] Includes pulp processes not shown separately.

Source: J. W. Austin, "Price Trends in Fiberwood Used by Mills in Northwest," Pulp & Paper, March 1973, p. 64

TABLE IV-8

CHIP PRICES BY SPECIES AND MILL TYPE
(1972 dollars per BD ton)

State and mill type	Hemlock		All whitewoods2		Douglas-fir		Pine		Redwood		Cedar		Hardwoods	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
WASHINGTON														
Pulp														
Sulfate	23.25	20.75-27.50	23.00	20.75-27.50	18.00	14.75-20.00	16.75	3	--	--	12.50	3	16.50	3
Sulfite	22.50	22.00-24.00	22.25	20.75-24.00	18.50	15.75-20.00	16.75	3	--	--	--	--	16.50	3
Groundwood	23.25	20.75-25.50	23.25	20.75-25.50	18.00	17.50-18.75	--	--	--	--	--	--	--	--
Other	22.25	20.75-24.00	22.25	20.75-24.00	19.50	18.75-20.00	--	--	--	--	--	--	--	--
Average4	23.50	20.75-27.50	23.25	20.75-27.50	18.00	14.75-20.00	16.75	3	--	--	12.50	3	16.50	3
Board	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OREGON														
Pulp														
Sulfate	--	--	20.75	3	16.25	15.00-18.75	23.25	3	--	--	--	--	17.00	3
Sulfite	17.75	16.75-18.75	18.25	16.75-19.00	12.00	3	--	--	--	--	--	--	--	--
Groundwood	--	--	19.50	19.00-20.75	14.25	12.00-18.75	--	--	--	--	--	--	17.00	3
Average4	17.75	16.75-18.75	18.75	16.75-20.75	15.25	12.00-18.75	23.25	3	--	--	--	--	19.25	17.00-22.50
Board														
Particleboard	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardboard and insulation board	13.50	3	13.50	3	15.48	13.50-18.00	--	--	--	--	--	--	--	--
Average	13.50	3	13.50	3	15.48	13.50-18.00	--	--	--	--	--	--	--	--
CALIFORNIA														
Pulp														
Sulfate	--	--	15.50	3	15.25	3	15.50	3	12.25	3	12.00	3	--	--
Groundwood	--	--	15.50	3	15.50	3	15.50	3	--	--	12.00	3	--	--
Average4	--	--	15.50	3	15.25	3	15.50	3	12.25	3	12.00	3	--	--
Board	--	--	10.50	8.00-13.00	8.00	3	8.00	3	11.00	3	--	--	--	--
Felt	--	--	--	--	--	--	--	--	17.25	16.00-18.50	10.00	3	--	--

1Rounded to nearest $0.25, prices f.o.b. consuming mill

2Includes hemlock

3Range $1 or less

4Includes pulp processes not shown separately

Source: J.W. Austin, "Price Trends in Fiberwood Used by Mills in Northwest," Pulp & Paper, March 1973, p. 65

- Date of Original Contract between Supplier and Buyer - An older contract, even with escalation clauses, usually pays lower prices in a market of rising prices and higher prices when market prices are declining.

- Transportation Distance - Prices vary significantly with the distance wood travels to the consuming mill. Although most mills report a uniform delivered price, many mills absorb some of the freight cost, or scale prices paid on a zone basis, to encourage deliveries from more distant suppliers.

- Mode of Transportation - In general, water transportation costs are lowest, followed by rail. Truck hauling, the most common method of transportation, is also the most expensive.

- Quality or Quantity - Although most survey respondents did not report paying a differential for quality or quantity of pulpwood, a few mills do this to obtain a consistent supply of softwood.

Although the survey referenced above was conducted in the Northwest, the same factors influence the cost of pulpwood in the other pulp-producing regions.

In general, pulpwood costs remained comparatively stable from 1950 to 1972. Obviously, there were exceptions in some geographic areas--specifically in the Southeast, where the competition for wood increased substantially. Furthermore, Southern mills generally paid less for pulpwood than those in the North Central or Northeast regions. In the northern states, spruce generally commanded higher prices than other softwood species or hardwood. (Table IV-9.)

This price stability might seem surprising, in view of the threefold increase in pulpwood consumption during that period and the generally rising costs of labor, power, and transportation. A variety of reasons contributed to this stability, chiefly the following:

- Increased use of residue wood from lumber and plywood plants, which grew from essentially zero in 1950 to 30% by 1970;

- Increased usage of lower-cost hardwood;

- Increased productivity of woods labor; and

- The availability of new pulp mill sites with a satisfactory supply of low-cost wood.

Pulpwood prices cannot be expected to remain stable indefinitely, as most factors that have promoted stability are no longer applicable. The use of residue wood and hardwood as a percentage of the total wood supply is expected to remain relatively constant. The more economical sources of waste wood are being exploited now, and additional supplies will come at

TABLE IV-9

PULPWOOD PRICES, BY SELECTED AREA AND SPECIES, 1950-73

(Dollars per standard cord, including bark)

Year	Midsouth [1]						Southeast [1]				Louisiana [2]			
	Southern pine		Hardwoods		Southern pine—Chips		Southern pine		Hardwoods		Southern pine		Hardwoods	
	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]
1950	12.15	14.85	10.65	13.00	....	....	11.90	14.55	....	....	....	....	....	....
1951	14.25	15.65	13.00	14.25	....	....	13.80	15.15	....	....	....	....	....	....
1952	14.30	16.15	12.90	14.55	....	....	13.90	15.70	....	....	....	....	....	....
1953	14.25	16.30	12.80	14.65	....	....	13.90	15.90	....	....	....	....	....	....
1954	14.30	16.30	12.85	14.65	....	....	14.00	16.00	....	....	....	....	....	....
1955	14.60	16.65	12.90	14.70	....	....	14.40	16.40	....	....	14.10	16.05	12.25	13.95
1956	15.65	17.25	13.50	14.90	....	....	15.40	17.00	....	....	14.40	15.90	11.95	13.20
1957	15.30	16.40	13.35	14.30	14.25	15.25	15.50	16.60	13.35	14.30	14.60	15.65	12.00	12.85
1958	15.30	16.15	13.10	13.85	14.30	15.10	15.50	16.40	13.45	14.20	14.75	15.60	11.90	12.60
1959	15.70	16.55	13.10	13.80	14.30	15.10	16.00	16.90	13.70	14.45	14.95	15.75	12.30	12.95
1960	16.05	16.90	13.10	13.80	14.40	15.15	16.45	17.35	13.60	14.35	14.85	15.65	12.15	12.80
1961	15.85	16.75	13.05	13.80	14.50	15.35	16.55	17.50	13.50	14.30	14.60	15.45	11.90	12.60
1962	15.80	16.65	13.20	13.90	14.55	15.35	16.55	17.45	13.40	14.15	14.50	15.30	11.90	12.55
1963	15.75	16.65	13.10	13.85	14.40	15.25	16.55	17.50	13.45	14.25	15.20	16.10	12.60	13.35
1964	15.90	16.80	13.15	13.90	14.30	15.10	17.00	17.95	13.60	14.35	15.25	16.10	12.95	13.65
1965	16.30	16.85	13.80	14.30	14.40	14.90	17.65	18.25	14.35	14.85	15.70	16.25	13.65	14.15
1966	16.85	16.90	15.05	15.10	15.15	15.20	18.80	18.85	14.90	14.95	16.50	16.55	14.80	14.85
1967	17.15	17.15	15.20	15.20	15.35	15.35	19.25	19.25	15.55	15.55	16.50	16.50	14.85	14.85
1968	17.75	17.30	15.85	15.45	15.80	15.40	19.85	19.35	15.60	15.20	17.00	16.60	16.30	15.90
1969	18.55	17.40	16.85	15.80	17.15	16.10	20.90	19.60	16.35	15.35	17.75	16.70	17.40	16.35
1970	18.80	17.05	16.95	15.35	16.40	14.85	21.10	19.10	17.15	15.55	17.70	16.05	17.45	15.80
1971	19.10	16.75	17.35	15.25	17.55	15.40	21.15	18.55	17.15	15.05	17.95	15.75	17.85	15.65
1972	20.80	17.45	18.55	15.60	17.90	15.00	22.85	19.20	18.95	15.90	19.25	16.15	19.00	15.95
1973 [3]											22.50	16.60	22.00	16.25

(Continued next page)

Source: "The Demand and Price Situation for Forest Products 1973-74" Misc. Publ. No. 1292, USDA, Forest Service, p. 74

TABLE IV-9 (Cont'd)

PULPWOOD PRICES, BY SELECTED AREA AND SPECIES, 1950-1973
(Dollars per standard cord, including bark)

Year	Wisconsin [3]								Northern New Hampshire [2]					
	Pine		Spruce		Hemlock		Aspen		Spruce and fir		Hemlock		Hardwoods	
	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]	Current dollars	1967 dollars [4]
1950	14.25	17.40	20.50	25.05	14.50	17.75	10.50	12.85	14.75	18.05	15.10	18.45	14.50	17.75
1951	18.25	20.05	26.25	28.80	17.75	19.50	15.00	16.45	18.75	20.60	15.25	16.75	16.75	18.40
1952	19.00	21.45	27.15	30.65	18.75	21.15	13.90	15.70	....	....	....	....	....	....
1953	18.10	20.70	24.75	28.30	17.15	19.60	12.85	14.70	....	....	....	....	....	....
1954	17.75	20.25	25.50	29.10	18.75	21.40	12.40	14.15	....	....	....	....	....	....
1955	17.50	19.95	25.75	29.35	18.25	20.80	12.50	14.25	....	....	....	....	....	....
1956	18.25	20.10	27.15	29.95	19.50	21.50	13.50	14.90	20.25	22.35	16.25	17.90	18.50	20.40
1957	17.90	19.20	27.65	29.65	19.00	20.35	12.75	13.65	22.25	23.85	17.75	19.00	19.25	20.65
1958	17.25	18.25	27.50	29.05	19.25	20.35	12.25	12.95	....	....	....	....	....	....
1959	18.75	19.80	27.75	29.25	19.25	20.30	12.90	13.60	....	....	....	....	....	....
1960	17.65	18.60	27.75	29.25	18.90	19.90	13.00	13.70	22.25	23.45	17.00	17.90	18.50	19.50
1961	18.00	19.05	27.25	28.85	19.00	20.10	13.00	13.75	21.00	22.20	18.25	19.30	17.60	18.60
1962	18.00	19.00	27.00	28.50	19.15	20.20	12.75	13.45	21.00	22.15	17.00	17.95	17.20	18.15
1963	17.75	18.80	25.75	27.25	18.75	19.85	13.75	14.55	21.00	22.20	17.00	18.00	15.70	16.60
1954	....	....	....	....	....	....	....	....	21.00	22.20	17.00	17.95	15.70	16.60
1965	....	....	....	....	....	....	....	....	21.00	21.75	17.50	18.10	16.10	16.65
1966	....	....	....	....	....	....	....	....	21.75	21.80	18.00	18.05	18.05	18.10
1967	21.40	21.40	29.90	29.90	21.25	21.25	15.75	15.75	22.10	22.10	19.75	19.75	18.05	18.05
1968	21.40	20.90	28.25	27.55	21.15	20.65	16.00	15.60	22.10	21.55	20.00	19.50	....	....
1969	20.90	19.60	28.50	26.75	21.00	19.70	16.00	15.00	21.00	19.70	19.00	17.85	18.90	17.75
1970	23.15	20.95	29.25	26.50	21.15	19.15	16.00	14.50	22.50	20.40	20.00	18.10	20.00	18.10
1971	22.75	19.95	28.50	25.00	21.00	18.45	16.00	14.05	22.50	19.75	18.50	16.25	22.00	19.30
1972	23.15	19.45	29.90	25.10	21.80	18.30	16.25	13.65	22.50	21.40	21.75	18.25	23.50	19.75
1973 [5]	26.10	19.25	30.75	22.70	24.00	17.70	18.60	13.75	30.00	22.15	22.50	16.60	26.50	19.55

[1] Weighted average of all pricing points.
[2] F.o.b. car.
[3] Delivered to mill.
[4] Derived by dividing price in current dollars by the Bureau of Labor Statistics wholesale price index of all comodities (1967=100).
[5] Preliminary.

Sources: U.S. Department of Agriculture, Forest Service. Louisiana Department of Agriculture. State Market Commission. University of Wisconsin. Forestry Department. University of New Hampshire, Cooperative Extension Service.

Source: "The Demand and Price Situation for Forest Products 1973-74" Misc. Publ. No. 1292, USDA, Forest Service, p. 74

higher prices. Also, the number of mill sites with an assured supply of low-cost wood is now severely limited. And finally, projected increased demands for primary timber products and new lumber manufacturing techniques will increase the competition for pole-size timber, which traditionally has been used almost exclusively for pulpwood. The Chip-N-Saw system, for example, will permit lumber manufacture from pole-size timber.

On the other hand, technological developments, such as whole-tree chipping and better utilization of logging residue, will tend to offset some of the upward pressure on the cost of pulpwood. Nevertheless, in general we believe the cost of pulpwood will increase faster than the overall rate of inflation--the question is, how much faster?

To gain some insight to this question, we next examine the cost elements of the delivered cost of wood: stumpage, harvesting, loading and hauling, and transportation.

E. PULPWOOD COST ELEMENTS

1. Basis of Evaluation

Four cost elements make up the delivered price of pulpwood at the pulp mill, namely:

- Stumpage,
- Harvesting,
- Loading and hauling, and
- Transportation

As implied in the previous discussion of alternative pulpwood sources, any or all of these cost elements might apply depending upon the origin of the pulpwood. For example, if a pole-size tree is cut for pulpwood and transported to the mill, all four factors would affect its price; on the other hand, if the pulpwood came from an integrated lumber and pulp manufacturing operation, it is conceivable that all of the cost elements would be charged to its lumber value. Hence, the residue from the lumber operation can be transferred to the pulp operation at a price lower than the cost of these items. In the case of pulpwood originating from logging residue, stumpage and harvesting would not apply; the costs would include simply loading and hauling.

Obviously, therefore, a variety of methods are used to obtain pulpwood and each has its own specific cost elements. In this analysis, we have considered the harvesting of roundwood and the newer practice of whole-tree harvesting; the applicable cost elements are discussed below.

2. Stumpage

Stumpage is the value of a standing tree. It varies with wood species, timber class, accessibility, and distance from a point at which the tree may be converted to a product of commerce. The buyer bases the stumpage he pays to the timber owner on the delivered price he will receive less the cost of harvesting and transportation. The stumpage value is also influenced by the supply/demand situation at the time of purchase. From the standpoint of the grower, stumpage represents the return on his timberland holdings and his forest management costs during the growth of the tree. Accordingly, stumpage (particularly for lumber and plywood-sized timber) can be highly variable and volatile. Stumpage rates are particularly important to pulp and paper producers who grow their own timber, because these rates directly affect the capital gains taxes that they must pay.

In spite of the possible inherent variations, the stumpage value of pulpwood was fairly stable from 1950 to 1973; however, it is likely to rise sharply with increased competition from primary timber products and as more intensive (hence costly) forest management practices are applied to meet the projected demand for timber products. Table VI-10 presents historical stumpage values for a variety of pulpwood species in major pulp-producing areas. The West is not represented in the tabulation; as most of that region's pulpwood is derived from manufacturing plant and logging residue, stumpage values do not apply.

3. Harvesting

Harvesting includes felling and bucking, i.e., cutting the tree and changing its form to facilitate transportation of the log to a loading station.

Harvesting methods and equipment vary in different areas of the United States, depending on the size and species of timber to be logged, the topography of the region, and the type of products desired. The technology has been improved over the past 30 years, but the United States is still considered behind both Scandinavia and Canada in implementing mechanization. Until recently, most of the R&D effort has been in privately sponsored, but ecological concerns and projections of future wood demand have spurred government sponsorship. For example, five U. S. Forest Service programs have been set up in areas with specific forestry problems (Alabama, Michigan, Montana, Washington, and West Virginia).

Pulpwood logging is generally simpler than sawtimber logging. In the pine forests, for example, smaller trees are cut into 4- or 8- foot lengths before being moved to a landing. Some whole-tree logging is also being done, and in some areas (e.g., West Virginia) whole trees are transported by a cable system. In the logging operation the tree is felled by a power chain saw or axe and then delimbed and put in a pile with other logs. If this operation is handled mechanically, a feller or feller-buncher is used, depending on whether or not the felled trees are collected together. The feller is usually a tracked vehicle that moves only a few feet; a feller-buncher may have tracks or wheels and moves over a larger area.

TABLE IV-10

PULPWOOD STUMPAGE PRICES, BY SELECTED STATE AND SPECIES, 1950-1973

(dollars per cord)

Year	Louisiana				Wisconsin								Northern New Hampshire			
	Southern pine		Hardwoods		Pine		Spruce		Hemlock		Aspen		Spruce and fir		Hemlock	
	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]	Current dollars	1967 dollars[1]
1950	...	...	...	...	3.75	4.60	5.50	6.70	2.25	2.75	1.90	2.30	4.00	4.90	1.75	2.15
1951	...	...	...	...	5.75	6.30	8.00	8.80	4.75	5.20	4.10	4.50	4.00	4.40	2.25	2.45
1952	...	...	...	...	5.25	5.95	7.00	7.90	2.90	3.25	2.40	2.70	...	...	...	...
1953	...	...	...	...	4.45	5.10	6.25	7.15	2.90	3.30	2.35	2.70	...	...	...	...
1954	...	...	...	...	5.10	5.80	6.50	7.40	3.00	3.40	2.40	2.75	...	...	...	...
1955	3.45	3.95	...	...	4.50	5.15	9.00	10.25	2.25	2.55	3.10	3.55	...	...	...	...
1956	3.85	4.25	1.60	1.75	5.70	6.30	7.10	7.85	3.50	3.85	2.35	2.60	4.00	4.40	2.00	2.20
1957	4.25	4.55	1.60	1.70	5.65	6.05	7.25	7.75	3.40	3.65	2.40	2.55	4.00	4.30	2.00	2.15
1958	4.25	4.50	1.65	1.75	4.75	5.00	7.85	8.30	4.15	4.40	2.45	2.60	...	...	...	...
1959	4.25	4.50	1.70	1.80	5.40	5.70	7.70	8.10	4.40	4.65	2.70	2.85	...	...	...	...
1960	4.40	4.65	1.60	1.70	5.05	5.30	7.25	7.65	4.00	4.20	2.95	3.10	4.25	4.50	2.00	2.10
1961	4.25	4.50	1.55	1.65	5.50	5.80	8.00	8.45	4.00	4.25	2.00	2.10	5.00	5.30	1.25	1.30
1962	4.25	4.50	1.55	1.65	5.15	5.45	8.25	8.70	4.20	4.45	2.45	2.60	4.50	4.75	1.75	1.85
1963	4.30	4.55	1.55	1.65	5.25	5.55	8.00	8.45	4.25	4.50	2.25	2.40	4.50	4.75	1.75	1.85
1964	4.30	4.55	1.65	1.75	...	...	...	...	...	...	...	...	4.50	4.75	2.00	2.10
1965	4.40	4.55	1.60	1.65	...	...	...	...	...	...	...	...	4.50	4.65	2.00	2.05
1966	4.55	4.55	1.70	1.70	...	...	...	...	...	...	...	...	5.25	5.25	3.00	3.00
1967	4.60	4.60	1.75	1.75	6.05	6.05	7.20	7.20	4.35	4.35	2.25	2.25	5.25	5.25	1.75	1.75
1968	4.65	4.55	1.85	1.80	5.50	5.35	8.05	7.85	4.90	4.80	2.75	2.70	5.25	5.10	1.75	1.70
1969	4.65	4.35	1.90	1.80	6.00	5.65	7.50	7.05	5.30	5.00	3.00	2.80	4.50	4.25	2.00	1.90
1970	4.70	4.25	1.95	1.75	6.50	5.90	7.10	6.45	4.75	4.30	3.00	2.70	4.50	4.10	2.00	1.80
1971	4.75	4.15	1.90	1.65	6.60	5.80	5.90	5.20	4.60	4.05	2.80	2.45	4.50	3.95	2.50	2.20
1972	4.75	4.00	2.10	1.75	6.45	5.40	6.00	5.05	3.85	3.25	2.90	2.45	4.50	3.80	2.50	2.10
1973[2]	5.20	3.85	2.40	1.80	6.00	4.45	7.60	5.60	5.10	3.75	3.10	2.30	5.50	4.05	3.00	2.20

[1] Derived by dividing price in current dollars by the Bureau of Labor Statistics wholesale price index of all commodities (1967=100).
[2] Preliminary.

Sources: Louisiana Department of Agriculture, State Market Commission
University of Wisconsin, Forestry Department   University of New Hampshire
Cooperative Extension Service

Source: "The Demand and Price Situation for Forest Products 1973-74" Misc. Publ. No. 1292,USDA, Forest Service, p. 76

The delimbing of large trees is usually done in the forest, while smaller or medium-size trees are delimbed at the landing area. One of the most difficult problems of mechanized harvesting in the Northeast is removal of the heavy, low-growing branches of the softwoods grown there; Scandinavian equipment is now being tested for this purpose.

Bucking, or cutting the logs into proper lengths, may be done in the forest or at a landing point. Intermediate transport of the logs from the forest to a landing area is accomplished in a number of different ways, depending on the terrain and type of wood to be handled. It can vary from the use of animal skidders in North Carolina and Virginia to skyline (cable) systems in the Pacific Northwest. The crawler tractor is the most universally used skidder, although large rubber tired tractors are used in swampy areas.

Debarked logs dry out more rapidly, resulting in lower freight costs and closer piling in shipment. Therefore, mechanical log barkers are sometimes used at pulpwood landings and concentration points. The bark is stripped off through rapidly rotating knives in a drum. If tree-length logging is practiced, debarking may precede cutting to proper size.

A variety of equipment is available for loading logs onto trucks. Boom power loaders on wheels or crawler tracks are generally used for big sawlogs or long logs, and tractors with fork lifts are used for smaller timber. Several types of chain loaders can be installed directly on hauling trucks.

Combines or harvesters are used in the logging industry, particularly on moderate slopes, for clear-cutting operations; they are especially adapted for use on plantations, where regular planting patterns improve their efficiency. Harvester perform from two to five operations, i.e., cutting, bunching, limbing, bucking, and skidding. They may or may not transport to a primary landing. There are also processors which perform other functions such as barking, chipping, and loading, but these are not usually part of a harvesting system. The Mobark Chiparvestor, which is used to chip whole trees in the forest without debarking, exemplifies this type of equipment.

Harvesting costs are primarily labor-related, and labor rates have escalated rapidly in recent years. The type of equipment used, the terrain, and the degree of mechanization also affect harvesting costs. In most areas there is a shortage of labor willing to work in the woods. Mechanized harvesting systems are used to overcome the shortage and high cost of labor. Table IV-11 compares mechanical and manual logging costs in North America. In shortwood harvesting the lower labor cost of mechanized harvesting is partially offset by a higher machine cost; the cost for the mechanized system is $2.32/cunit less than for a manual operation. The difference with tree-length harvesting is not as great; the total cost of a fully mechanized system is $0.84/cunit and a semi-mechanized system is $1.70/cunit less than a manual operation. A semi-mechanized full-tree logging system costs about the same as one that is fully mechanized.

TABLE IV-11

COMPARISON OF LOGGING METHODS IN NORTH AMERICA

Logging Method	Production (Cunits/man-day)	Cost, 2nd Quarter 1974 ($/Cunit) Labor	Machine	Total	Comments
Shortwood					
Manual	2.3	16.05	2.72	18.77	Strip, cut and forward to roadside
Mechanized	18.0	3.10	13.35	16.45	Koehring-Waterous Harvester
Tree-Length					
Manual	4.0	13.71	3.37	17.08	Manual felling and limbing, bucked by power saw
Mech. Slashing Roadside	5.2	10.22	5.09	15.31	Manual felling and limbing
Mechanized	8.0	6.72	9.52	16.24	
Full Tree (chips)					
Semi-Mechanized	4.7	7.95	8.50	16.45	Manual felling
Mechanized	7.0	6.19	10.17	16.36	

Source: Private communication with woodlands manager of large U.S. paper manufacturer

Evaluation of any cost data dealing with multifunction machines requires information on the machines' availability so that an accurate assessment of cost over a period of time can be made. In addition, availability and cost of more highly trained labor must be considered in assessing the benefits of shifting to a mechanical harvesting system.

4. Loading and Hauling

As the term implies, this step includes loading the pulpwood onto a vehicle and hauling it to a mill. Note that in addition to the transportation cost considered under (5) below, a portion of the transportation cost is included in this item--namely, that for moving the pulpwood comparatively short distances by intermediate truck transportation to a railhead or barge site. The cost discussed in subsection (5) is for longer distances (greater than 50 miles).

Contingent upon the choice of the preceding harvesting step, short wood (4- or 8-foot bolts), tree-length logs, or chips may be loaded onto a vehicle for transportation. The cost of loading and short-distance hauling is estimated at $8-10/cunit for short wood via truck transportation. Specific factors that influence loading and hauling costs are size of the truck, inter/intrastate transportation, and regional costs for fuel and labor. Hauling costs for up to a 50-mile radius from a mill are included.

5. Transportation Patterns and Costs

Roundwood or residues for pulping are transported by rail, truck, barge, and various combinations of these methods, depending on such factors as the geographical location of the pulp mill, hauling distance, and economics. Generally, short hauls of either roundwood or residues are made by truck, although trucks have been used for distances up to 200 miles. The largest proportion of pulpwood is moved by rail, sometimes in combination with truck and barge. Most of the pulpwood and chip transportation is intrastate, although interstate movement is increasing in the Pacific Northwest and in the South.

Transportation rates have increased over 40% in the past five years and are expected to continue their rapid rise. Rail tariffs increased 7% across the board in February 1975; increased labor costs, OSHA requirements, and the need for new rail equipment have been the major causes. Recognizing the importance of transportation costs, the paper industry is setting up regional traffic conferences to study the problems and work toward equitable solutions.

The costs of truck transportation are not publicly reported, since they are determined by contracts or private negotiations. In many situations the cost has not been calculated especially for deliveries by small farmers. The choice between trucks and rail for wood transportation is generally made on the basis of economics, although the physical arrangement of the woodyard sometimes favors one over the other. Forest products companies that own their woodlands frequently supplement public transportation with their own trucks.

In discussions with a number of paper companies throughout the country, a wide range of trucking costs per cord-mile have been reported to us. Rather than reflecting regional differences, they vary with the size of the logging and trucking operation, whether or not trucks are owned by a forest products company, and (in the case of privately owned vehicles) whether the labor is union or nonunion. On the basis of information reported to us, the average truck transportation cost is about ten cents per cord-mile for a one-way haul; however, it can range from 8 to 15 cents, depending on the many variables previously mentioned. We have not estimated regional variations, since other factors are more significant.

Figure IV-7 shows typical transportation costs for pulpwood by region. Trucking costs are included in these figures, even though we have not indicated regional variations, so that a direct comparison with rail costs can be made. Rail rates were obtained from carriers in each region, and are shown for both roundwood and chips, where possible. (There are no established rates for moving chips by rail in the Northeast or for moving roundwood by rail in the West.)

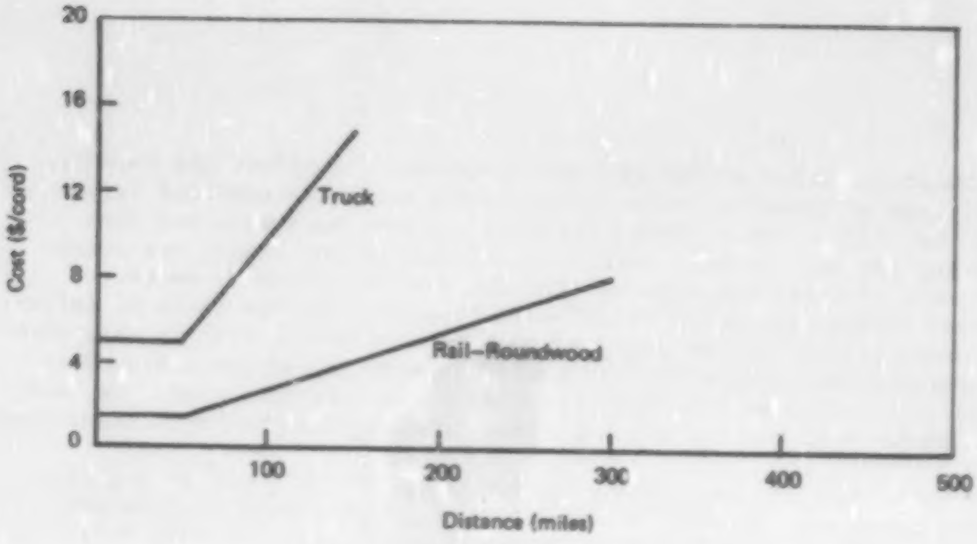
The average distance for rail shipments is 120 to 150 miles in the Northeast, North Central, and South regions, although much longer shipments are common in the South when wood is in short supply. The average distance for rail shipments in the West is 500 miles.

Table IV-12 shows the distribution of roundwood and chip (residual) shipments by truck and rail for the South for the years 1973 and 1978. In contrast, chips account for almost 80% of the wood fiber used for pulping in the West; both rail and truck shipments are important in that section of the country.

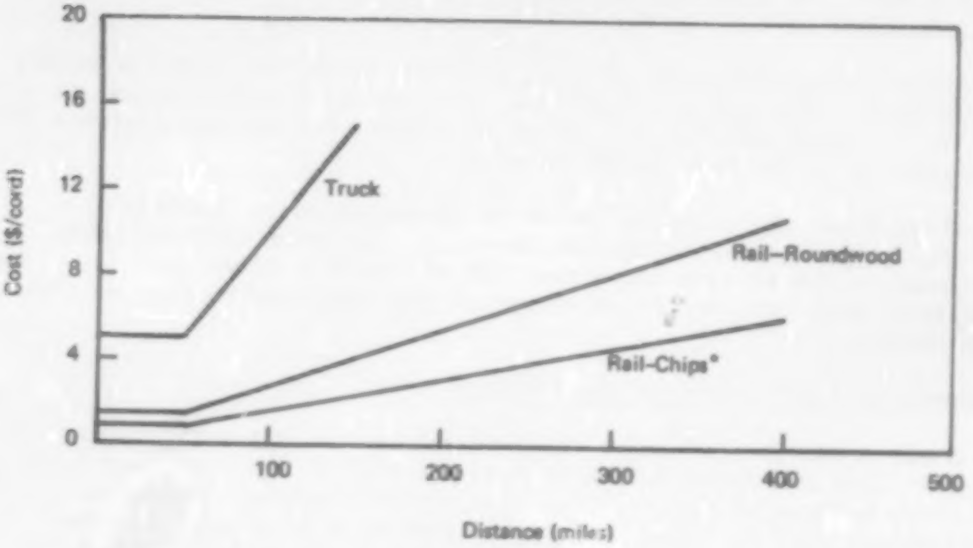
6. Summary of Delivered Cost for Pulpwood

Table IV-13 summarizes the cost elements and indicates representative costs for rough roundwood delivered to a pulpmill in the four major geographic sections of the country. For several reasons, including the mixture of various forms of pulpwood used by a given mill to make up its requirements, delivered cost of roundwood can vary significantly from these derived values. Nevertheless, the tabulated costs provide a reasonable basis for comparing the competitive positions of virgin and recycled fiber.

The cost of pulpwood in the South and West is significantly less than in the Northeast and North Central sections because of lower stumpage values and harvesting costs. Furthermore, the densities of softwood pulpwood are higher in the South and West, so the cost on a weight basis is even lower than on a unit volume basis. Wood densities and pulp yields for selected softwood and hardwood species are listed in Appendix B-3.



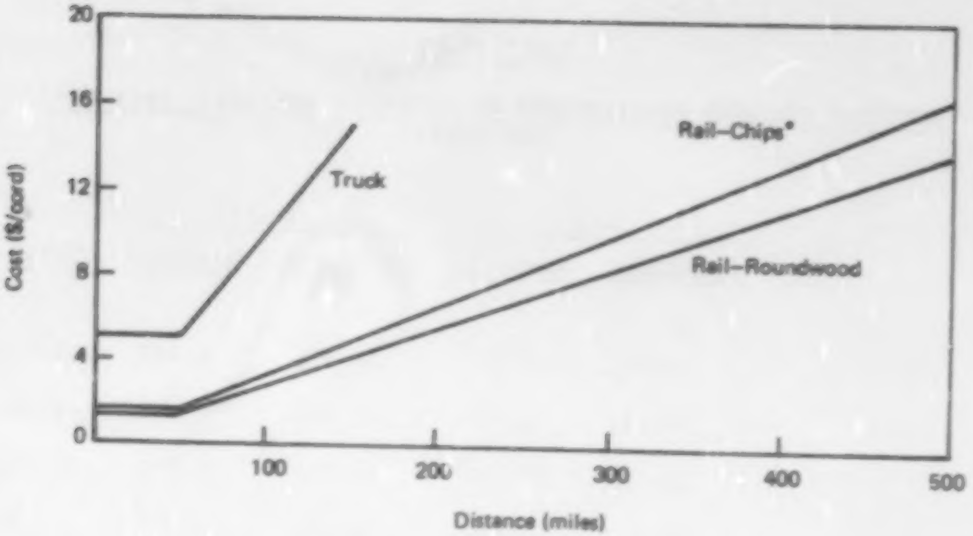
a. Northeast



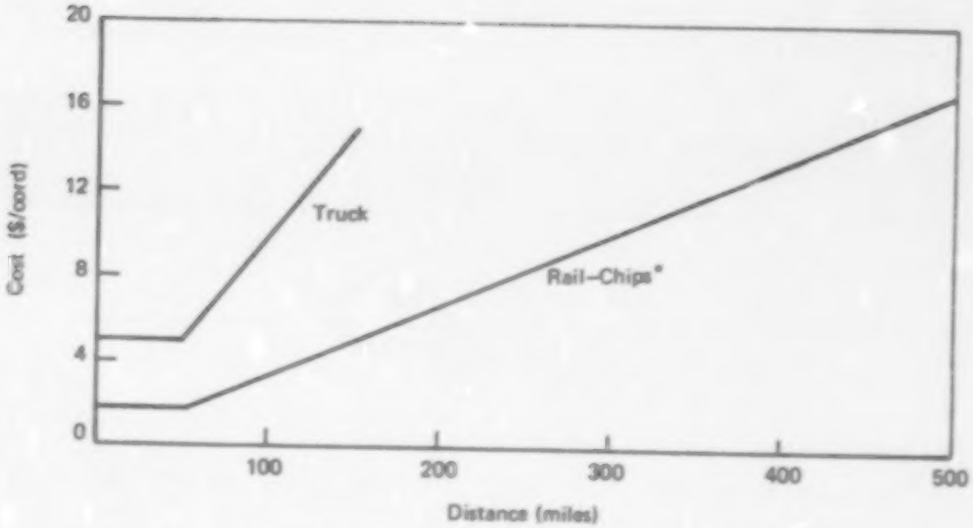
b. North Central

*190 cu ft chips equivalent to one cord roundwood.

FIGURE IV–7 TYPICAL TRANSPORTATION COSTS FOR PULPWOOD, THIRD QUARTER 1974



c. South



d. West

*190 cu ft chips equivalent to one cord roundwood

Sources: **Truck rates** – ADL in-house information and private communications; **Rail rates** – (Northeast) Maine Central RR, Boston & Maine RR; (North Central) Chicago & Western RR; (South) Southern Paper Manufacturers Traffic Conference; (West) North Pacific Coast Freight Bureau and private communication.

FIGURE IV–7 (Cont'd)

TABLE IV-12

SOUTHERN PULPWOOD REQUIREMENTS BY METHOD OF DELIVERY, 1973-1978

(000 cords)

	Rail		Truck[a]		
	Roundwood	Residual	Roundwood	Residual	TOTAL
1973	16,256	7,812	14,923	6,472	45,463
1974	17,462	9,349	14,604	7,604	49,019
1975	16,482	10,708	14,564	8,242	49,996
1976	16,098	12,129	14,698	8,667	51,592
1977	16,336	13,663	15,107	9,321	54,427
1978	16,434	13,897	15,173	9,320	54,824
1973-78	178	6,085	250	2,848	9,361
			(Percent)		
Increase 1973-1978 by Method of Delivery[b]	1.9	65.0	2.7	30.4	100

[a] Includes pulpwood transported by water.

[b] Increase by method of delivery, expressed as a percentage of total increase.

Source: J. A. Altman, "Pulpwood Needs Forecast by Southern Pulp Mills," Pulpwood Production & Timber Harvesting December 1974, p. 17.

TABLE IV-13

ESTIMATED DELIVERED COST OF PULPWOOD BY MAJOR GEOGRAPHIC SECTION

(2nd quarter 1974 dollars per cunit)

	Northeast		North Central		South		West	
	SW	HW	SW	HW	SW	HW	SW	HW
Stumpage	8[a]	4[b]	8[a]	4[b]	7	4[b]	Not Applicable	
Harvesting	14	14	14	14	12	12	"	"
Loading and Hauling[c]	8	8	8	8	7	7	"	"
Transportation	d	d	d	d	d	d	"	"
Forestry Management, road maintenance, and supervision	2	2	2	2	2	2	"	"
Total	32	28	32	28	28	25	38	28
$/Metric ton	32	21	32	21	23	18	32	21

[a] Applies to spruce and fir; stumpage for less desirable species would be less.

[b] Applies to dense hardwood; stumpage for low-density hardwoods (e.g., poplar and aspen) would be lower.

[c] Hauling up to 50-mile radius of pulp mill; longer hauls would be in addition.

[d] Transportation beyond 50-mile radius of mill is shown separately for each cost model in Section IX.

An examination of each of the principal cost elements indicates that all are likely to rise faster than the general economic indicators of inflation.

- Stumpage will rise because of increased competition for timber and more intensive forest management;

- Harvesting costs will increase because of the need for more capital-intensive mechanized equipment and environmental regulations;

- Loading/hauling and transportation will be more expensive because of escalating costs of fuel, OSHA regulations on noise and safety, and environmental restrictions on air emissions from trucks.

One measure of the degree to which U.S. pulpwood prices will rise is present differential between Scandinavian and U.S. wood. In recent years, Scandinavian prices for both softwood and hardwood have been about 30-40% above U.S. prices. If domestic firms have to adopt the intensified forestry management practices of the Scandinavian companies and pay comparably high energy costs, U.S. pulpwood costs will rise an average of about 3-4% per year beyond that due to inflation and will reach current Scandinavian levels in ten years. Obviously, regional differences in various sectors will influence this anticipated cost increase.

F. IMPACT OF EMERGING TECHNOLOGY ON PULPWOOD COSTS*

Pulpwood costs could be reduced by the application of two technological developments: (1) new forest management practices, which would increase timber supplies, and (2) the better use of the fibrous raw material in the pulping reaction, e.g., by pulping the whole tree. Each of these subjects is further discussed below.

1. Forest Management

Data accumulated during the 1960's demonstrated that dramatic improvements in timber yield are possible under proper conditions. However, technical opportunities for increasing yields and thereby improving returns on investment vary widely from stand to stand and from region to region; for this reason, it would be very difficult to estimate what overall improvement might be achieved.

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*This discussion is based on Chapter III of the previously referenced USDA publication "The Outlook for Timber in the United States."

In this section we will discuss some of the practices now at various stages of development that contribute to improved forest management. The opportunities for greater timber growth and harvest in various sections of the country will be discussed. Forest management is still a developing technology, but sufficient data are available from existing applications to permit a rough assessment of its future economic impact. It must be remembered, however, that private land owners need an economic incentive before they will change their forestry practices.

The general opportunities for improving timber supplies by using better forestry technology include the following:

Accelerated regeneration

Stand conversion

Commercial thinning

Fertilizaton

Improved insect and disease control

Improved fire protection.

Regeneration can be accelerated by stand improvement and by greater use of genetically improved stock. The plantations in the South are excellent examples of this practice; an estimated quarter of the planting stock seed used in the South's timber industry in 1970 came from selected superior trees. Research programs are now under way to produce seedings from superior trees, and in 1970 about 15% of the seedlings produced by state and federal nurseries were from improved seeds. It is also possible to obtain desirable properties as well as higher yields of fiber by using genetically selected tree stocks.

Stand Improvement - It has been demonstrated that an important method for increasing yields in heavily stocked stands is precommercial thinnings; i.e., removal of undesirable trees at an early stage.

Commercial Thinnings - Cutting of saleable trees to improve spacing and stimulate growth of crop trees is still not widely practiced in the United States. Many research studies show that this is a particularly valuable method for concentrating growth on the more valuable trees.

Fertilization - Most of the research on the use of fertilizers to improve and accelerate tree growth has been in the Pacific Northwest and in the South, principally by industrial forest owners. Applications of nitrogen, sometimes in combination with other nutrients such as phosphorus, can result in increased timber yields.

Insect and Disease Control - The annual mortality and growth reduction attributable to southern pine beetles, western dwarf mistletoe, and western bark beetles are estimates to be about 13% of the current timber harvest. Although numerous research programs have been undertaken in recent years to reduce this loss, only partial success has been achieved. The information necessary to develop complete control techniques is not available. Potential developments could include use of attractants or repellents; feeding of deterrents, hormone sterilants, use of pesticides and antibiotics, and improved cultural methods.

Fire Protection - The largest and most effective forestry effort in the United States has been in fire control. There are opportunities to use new technology for more effective fire detection (using airborne infrared sensors, for example) and better control of forest fires.

Development of markets for logging residues provides incentives for cleaning up cutover areas, which reduces the accumulation of flammable brush in these regions.

Growth Stimulants - The use of chemicals to improve timber growth has demonstrated that yields can be increased through their use. The most widely tested material is giberellin.

Economic Aspects - Intensified forest management requires an investment that must offer the private land owner the possibility of economic return. As part of government efforts to encourage better forest management, the Forest Service prepared regional estimates in 1972 of possible increases in supplies of softwood timber from national forests, farms, and miscellaneous private holdings by intensification of forest management. Other public lands and forest-industry-owned lands, which make up 9% and 14% of the total commercial timberland respectively, were not included; however, forest industry owners have already implemented good forestry practices, and these are expected to continue.

In the Forest Service study, areas were classified according to physical condition and management options. The cost of intensified timber growing practices and anticipated increases in timber harvests were then estimated. Not all possible technologies were considered in the study. The findings for each region are reported below.

- Northeast

  Forty-two million acres of commercial timberland, predominantly hardwoods of the oak-hickory type (southeastern Ohio) and maple-birch-beech type (Maine) were selected as suitable for intensified forest management. The objective of the program would be to grow the highest quality sawtimber the site could produce in the shortest reasonable time. Periodic thinnings and the planting of genetically improved stock were the forestry practices deemed acceptable.

The estimated costs per acre (at 1970 prices) were:

	Range	Average
Stand Conversion	$10 - 20	$15
Improved Cutting	$14 - 28	$19
Precommercial Thinning		$21.50

In the pilot area under consideration, under the 1970 price assumptions, an average increase in net worth per acre due to intensive forest management averaged $34.14 at an average cost of $27.32 per acre. Stand improvement cost an average of $17.22 per acre but increased the present net worth by only $12.56 per acre. As wood prices rose, the average net worth per acre increased, providing more incentive for intensified management. At least 50 years are required for harvesting and a return on investment.

- North Central

Three predominantly hardwood forests were selected as areas suitable for intensified forest management. Practices assumed to be most suited included reforestation with softwoods, mostly red and white pine, and scheduled thinning.

Estimated costs for softwood planting were $45.60 per acre. Harvests from softwood sawtimber planting would be minimal until the fourth decade, when the annual increase per year would reach 53 million board feet. In the eighth decade the estimated annual harvest would be 567 million board feet, which would be twice the 1970 softwood sawtimber output of the region. Investments in site preparation for aspen (at 1970 prices) were estimated to cost $5.20 per acre, and the pulpwood harvest increase was estimated to be 130 million board feet per year in the fifth decade. Improvements in northern hardwood stands (at 1970 prices) were estimated to cost $13 per acre, and the increase in harvest would be 344 million board feet annually.

- South

Opportunities for changing timber supplies in this area vary widely due to differences in species, sites, and land ownership patterns. The areas considered suitable for intensified management include 10.7 million acres of young stands plus 26.5 million acres that require regeneration or planting. In the former areas, precommercial and commercial thinnings were judged necessary to increase timber yields. On the 26.5 million acres which would require reforestation, a breakdown into good and medium sites was made to take into account the large variations in potential yields of pine plantations. Control of fusiform rust appears most likely through development of more resistant planting stock. Weevils require treatment with insecticide. The average cost of forestry practices in the Southeast varies with the region; for example, the average cost of establishing a pine plantation is estimated to be about $44.75 per acre and may be even higher, since most of the easy planting areas have already been utilized. Other forestry practices range from controlled burning at $2.05 per acre to cutting of overgrowth to encourage the growth of more desirable species at $15.50 per acre.

- West

In the West, the economic potential for increasing timber harvest by intensified forest management was analyzed for commercial timberland ownership class on 35.1 million acres. Westside conifer stands were judged to be best served by thinning, fertilization, conversion of hardwood stands to Douglas fir, and reforestation. Ponderosa and lodgepole pine stands would benefit from thinning.

Based on 1970 prices, average per-acre costs were as follows:

Planting (Westside conifers following harvest)	$35
Precommercial thinning	$50
Fertilization	$22
Site preparation for conversion of hardwood stands less than 45 years old	$40

In this region, the time required for harvest and return on investment is 60 years.

2. Pulping Technology

Innovative methods of pulp production are being developed, but it is doubtful that any of these new processes and equipment will be in sufficient use to have a major quantitative effect on pulp production (and hence pulpwood prices) within the next decade. The proposed changes can be categorized as (a) those dealing with the chemistry or mechanics of fiber production and (b) those related to the selection and use of the fiber raw material.

Since the use of kraft pulp will continue to dominate in the manufacture of paper and board, the success of new processes will be based on an ability to compete with the kraft process--i.e., to produce at least equivalent yields and properties of pulp from a variety of woods and wood residues. Several promising candidates have been developed in the laboratory and are currently under investigation. One group is the so-called "oxygen pulping processes."

Oxygen pulping processes are considered by many to be a leading challenger to the kraft process. Only one company has performed limited mill trials on a two-stage process using soda pulping followed by oxygen delignification. In a related development, Toyo Pulp has used its High Oxygen Pulping Enclosed Systems (HOPES) in a 2-tpd pilot plant for several years. Other processes are still in the laboratory development stage.

Several other chemical pulping processes have been under development for a number of years, but commercial operation is still in the future. These include an alkaline-sulfite process proposed by Canadian International Paper and a sulfite-sulfide process developed by Owens-Illinois. Another is the holopulping development by the Institute of Paper Chemistry, which is based on a mild oxidation of lignin with chlorine dioxide solution followed by alkaline extraction. Nitric acid pulping is under consideration by two North American mills, but this process is believed to have only limited applications.

Chemical-solvent pulping offers little immediate potential for commercial production.

Modifications of the conventional kraft process to obtain higher yields are currently being offered by several companies on a licensing basis. These include a pretreatment with H_2S (MacMillan Bloedel Ltd.), oxidation of sulfide in white liquor to produce polysulfides (Union Camp Corporation), irradiation of wood chips prior to normal kraft cook (Radiation Development Ltd.), and a modified kraft process presumably based on polysulfides (Mead Corporation). These processes permit better utilization of wood, but their use within the next decade will be on a selected basis and will have no significant effect on pulpwood prices.

Mechanical pulping is expected to grow in importance, because it minimizes wood consumption per ton of pulp. The use of waste wood for mechanical pulp production, especially refiner types, is increasing. In many grades of printing papers, mechanical pulp may soon comprise all or large percentages of the fiber furnish. The use of thermal or chemical pretreatment produces modifications of mechanical pulps and increases their usefulness. Although there will be some substitution of mechanical pulps for chemical pulps in paper and board manufacture, no significant effect on pulpwood prices is expected.

The quality of fibrous raw material used by pulp mills has changed over the past five years. There is a tendency to deliver logs of variable length and diameter to the pulp mill. Whole-tree chipping, either in the woods or at the woodyard, and the use of tops and branches has introduced the use of unbarked wood in the digester. This has significantly increased the potential amount of usable pulpwood from the forest, but it has also expanded the operating variables in the pulp mill. Nevertheless, by October 1973 about 40 mills were reportedly making trials with whole-tree chips as part of their furnish for paper and paperboard.* Eight were making bleached paper and board grades, seven linerboard, and twenty-four corrugating medium. Another twenty mills were evaluating whole-tree chips in construction paper and board manufacture.

The advantages of higher yields from the forest by using unbarked thinnings, tops, and branches are at least partially offset by problems in the pulp mill. Chemical requirements are increased, pulp yield and quality are affected, and there is an increased solids load to the recovery boiler, which reduces its capacity on a fiber basis.

As experience is gained in the use of unbarked wood, papermakers will be in a better position to evaluate the effect on their manufacturing costs. Whole-tree chips can be delivered to the digester at lower cost than roundwood chips, so there will be continuing pressure to increase their use. Actual cost savings will be apparent only when additional mill processing costs are compared with the costs using good roundwood chips. The use of total tree-chips will find wider use in the coarser grades of paper and board; extension of their use in the finer grades will come more gradually. We believe, however, that no substantial effect on pulpwood prices will be felt in the next decade as a result of whole-tree utilization in pulping.

The increased use of hardwoods is particularly apparent in the North and South regions. Prices for hardwoods will thus continue to rise and approach those for softwoods in these regions.

G. SUMMARY OF WOOD RESOURCE ANALYSIS

The following summarizes the salient findings and conclusions discussed in this section.

- Pulpwood is both a by-product of and in direct competition with timber harvested for primary timber products.

- Competition for standing timber is likely to increase as new lumber manufacturing technology makes it economically attractive to make lumber from pole-size timber which traditionally was used exclusively for pulpwood. Conversely, new pulpwood harvesting technology, such as whole-tree chipping in the woods, reduces the likelihood of selectively taking a few sawlogs from a pole-size timber stand.

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*Pulpwood Production, August 1973.

- Public ownership of the commercial timberlands and growing stock is a significant feature of the U.S. wood resource. This is particularly true in the West, where 67% of the timberland and fully 71% of the growing stock is publicly owned.
- The total annual growth of timber exceeds the total annual removal of all but the Western area.
- Timber growth per acre could be approximately doubled in all sections by demonstrated intensive forestry management.
- An adequate supply of timber is available for all projected demands throughout the next decade; better forest management practice will be required to assure our timber supply beyond 1985.
- There is considerable variation in the origin of pulpwood and the method by which it is delivered to a pulp mill. Together with the distance from the mill, these are the principal factors that influence the delivered cost.
- Pulpwood costs have been historically lower in the South and West than in the Northeast and North Central. The cost differential in these areas is likely to continue.
- Pulpwood costs have remained comparatively stable over the past two decades. For a variety of reasons we do not expect this historical stability to continue through the next decade.
- We estimate that pulpwood costs will increase at a faster rate than overall inflationary trends. Obviously, specific regional factors will influence the rate of increase in cost, but on an overall basis we believe that annual increases will exceed those due to inflation by 3-4%.

V. CHARACTERISTICS OF THE WASTE PAPER INDUSTRY

This section deals with the characteristics of the waste paper industry and the historical patterns of waste paper usage. It also includes a discussion of the terms used in the industry, the correlation between paper stock grades and paper and paperboard products, and the structure of the industry. The information was derived from both published and unpublished sources and was validated where possible by direct contact with waste paper dealers, industry associations, and key management personnel of paper and paperboard mills that rely upon waste paper for a significant portion of their fiber furnish.

This analysis is presented to show how the characteristics of the industry influence the potential cost and availability of waste paper to the pulp and paper industry. It is not intended to be a detailed study of the organization and business dynamics of the industry; these subjects have been examined by others.*

A. DEFINITION OF TERMS

Historically, a number of dissimilar terms have been used to report waste paper usage by the pulp and paper industry, which has caused confusion and misinterpretation of data. Accordingly, before entering into a discussion of waste paper usage, a definition of certain terms used in this report is appropriate.

1. Recovery Rate

Recovery rate (also called "salvage rate" or "collection rate") denotes the amount of waste paper that is collected, expressed as a percentage of the total paper consumed for the reporting region, i.e.,

$$\text{Recovery Rate} = \frac{\text{amount collected}}{\text{amount consumed}} \times 100$$

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*See, for example, the following:

- Battelle Memorial Institute, "Study to Identify Opportunities for Increased Solid Waste Utilization", report to National Association of Secondary Material Industries, Inc., 1972
- A.B. Dickerman, "Economics of the Waste Paper Industry," Doctoral Thesis, Syracuse University, 1957.
- S.G. Tuchman, "The Economics of the Waste Paper Industry," Doctoral Thesis, New York University, 1963.
- Midwest Research Institute, "Base Line Study of Resource Recovery from MSW," 1972-1990, report to Environmental Protection Agency (in preparation)

Implicit in the term is an accounting of any imports or exports of paper or paperboard products. Accordingly, the recovery rate compares to actual quantity collected with the theoretical supply available for recycling. We stress "theoretically available," since the definition of the term does not discount the available supply for nonrecoverable quantities such as those included in disposable tissue products and construction papers (e.g., roofing shingles) which lose their identity as paper products.

In addition to this generalized meaning, we have also used the term "recovery rate" more explicitly to denote the amount collected, expressed as a percentage of:

- the original product(s), or
- the quantity economically available from recovery. (See definition of collectable tonnage.)

Naturally, we indicate how the term is used in each instance.

2. Consumption Rate

Consumption rate (also called "furnish rate" and "recycling rate") denotes the amount of waste paper consumed, as a percentage of the total papermaking fiber used, in the manufacture of paper and paperboard within a studied region, i.e.,

$$\text{Consumption Rate} = \frac{\text{amount of waste paper consumed}}{\text{amount of fiber used}} \times 100$$

The difference between recovery rate and consumption rate is particularly important in regions (such as California) that export substantial quantities of waste paper. As discussed more fully later, the comparatively low "consumption rate" of certain waste paper grades presents a misleading indication of possible greater utilization of secondary fiber in that area; it is only when the export tonnage is added to the quantity reused in that region that the true extent of S/F utilization is seen. Accordingly, consideration is given to the quantity and point of debarkation of export tonnage in the assessment of opportunities for the increased use of waste paper.

3. Collectable Tonnage

As used in this report, the collectable tonnage is the quantity of waste paper economically available for recovery. The concept involves a judgmental assessment of what is "economically available." The factors that influence collectable tonnage are dependent upon the uses of the paper and paperboard products from which the individual waste paper grades are derived; hence, these factors are discussed separately in our analyses of the individual grades. (See Section VI.)

Note that collectable tonnage is defined as the amount economically available for recovery but not necessarily economically available for reuse in traditional paper and paperboard manufacturing operations. For example, Alaska may have a considerable quantity of waste paper that is economically available for recovery (collectable tonnage), but the quantity is not sufficiently large to support a recycling papermaking operation in that area. Also, transportation costs to deliver the waste paper to a recycling operation would no doubt be prohibitively expensive. Hence, while that quantity of paper will support a collection and baling operation, it is not economically available for a recycling operation. Other factors that influence the economical reuse of collectable tonnage are discussed in Section X-B.

B. HISTORICAL USAGE PATTERN

1. Domestic Consumption

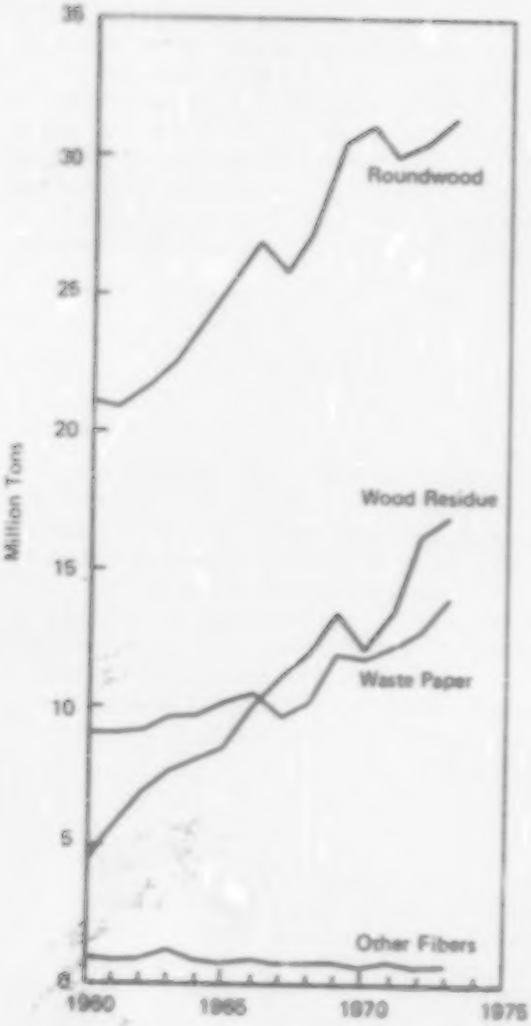
On the basis of preliminary data published for 1973, the consumption rate (as defined above) for the United States as a whole was about 22%. This represented a modest but continuing increase that started in 1968. Prior to 1968, the consumption rate had been declining steadily since 1951. Figures V-1 and V-2 and Table V-1 summarize the sources of fibrous raw materials used from 1960 to 1973. The consumption figures have been reported both as a percentage of total fiber and actual tonnage to give proper perspective to the fact that with the exception of some minor variations, the quantity of waste paper used by the industry has been increasing steadily, although its percentage of total fiber requirement has been relatively constant.

2. Exports

Historically, waste paper exports have been a small fraction of the total recovered, accounting for less than 5% of the total tonnage. However, 1973 exports increased significantly, rising from 415,000 tons in 1972 to 683,000 tons in 1973. Tables V-2 and V-3 indicate the recovery of waste paper by major category and the calculated U.S. recovery rates from 1968 to 1973.

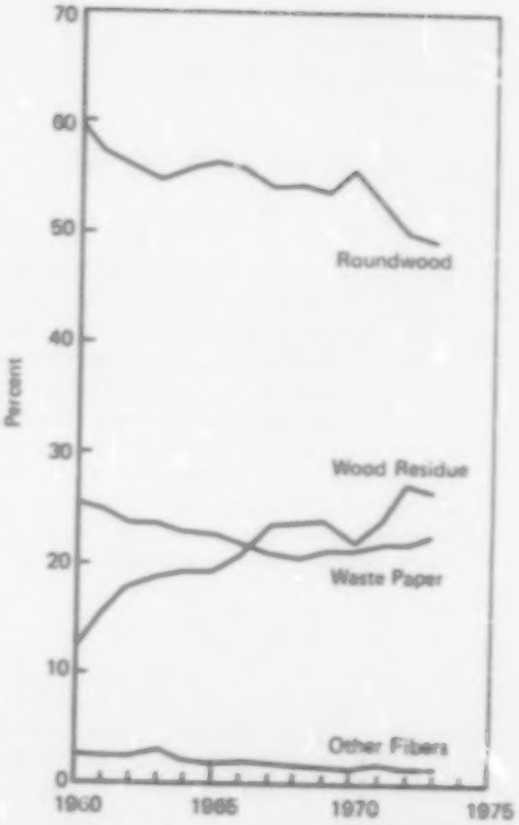
Census Bureau data on exports combine all grades and are not broken down by major waste paper categories. From information obtained in field interviews, we estimated the composition of these exports in 1973 and apportioned the tonnages to major geographic regions on the basis of published data on export volume (Figure V-3). The results are shown in Table V-4.

Note in Table V-4 that about 50% of the total exports are from the West Coast. Hence, the "consumption rate" is quite dissimilar to the "recovery rate" in that region. The implication of this characteristic will be discussed in Section VI, which concerns the availability of waste paper.



Source: American Pulpwood Association, 1973

FIGURE V–1 CONSUMPTION OF FIBROUS MATERIALS IN PAPER AND PAPERBOARD MANUFACTURING



Source: American Pulpwood Association, 1973

FIGURE V–2 PERCENTAGE OF TOTAL FIBROUS MATERIALS CONSUMED

TABLE V-1

FIBROUS RAW MATERIALS USED IN PAPER AND PAPERBOARD MANUFACTURE

Year	Roundwood[a] (000 tons)	Roundwood[a] (%)	Wood Residue (000 tons)	Wood Residue (%)	Waste Paper (000 tons)	Waste Paper (%)	Other Fibers (000 tons)	Other Fibers (%)	Total Fibrous Materials (000 tons)	Total Fibrous Materials (%)
1960	21,331	59.75	4,369	12.24	9,032	25.30	971	2.71	35,703	100.00
1961	20,973	53.72	5,710	15.60	9,018	24.64	894	2.44	36,595	100.00
1962	21,678	56.11	6,921	17.91	9,075	23.49	963	2.49	38,636	100.00
1963	22,514	54.76	7,706	18.74	9,613	23.38	1,285	3.12	41,117	100.00
1964	23,905	55.77	8,182	19.09	9,843	22.97	929	2.17	42,860	100.00
1965	25,369	56.23	8,638	19.15	10,231	22.67	879	1.95	45,116	100.00
1966	26,879	55.46	10,043	20.72	10,564	21.80	980	2.02	48,466	100.00
1967	25,824	54.01	11,226	23.48	9,888	20.68	873	1.83	47,811	100.00
1968	27,374	54.27	12,031	23.82	10,222[b]	20.27[b]	831	1.64	50,440	100.00
1969	30,455	53.59	13,555	23.85	11,969[c]	21.06[c]	849	1.50	56,828	100.00
1970	31,244	55.82	12,150	21.71	11,800[d]	21.08[d]	783	1.39	55,977	100.00
1971	30,465	53.32	13,680	23.95	12,110	21.20	875	1.53	57,130	100.00
1972	30,550	49.95	16,790	27.45	13,930	21.14	890	1.46	61,160	100.00
1973[e]	31,560	49.53	17,300	27.15	13,900	21.81	960	1.51	63,720	100.00

---

[a] Based on American Pulpwood Association Data

[b] Last year for use of Bureau of Census data for waste paper

[c] Institute of Paper Chemistry data

[d] American Paper Institute data; excludes 200,000 tons of other uses and 400,000 tons exported

[e] Preliminary

"Wood Pulp Statistics - 35th Edition," Pulp Division, American Paper Institute, November, 1971;
"The Statistics of Paper, 1974," American Paper Institute, American Pulpwood Association

TABLE V-2

RECOVERY OF WASTE PAPER IN THE UNITED STATES, 1968-1973
(thousands of short tons)

	1968	1969	1970	1971	1972	1973
Domestic Consumption						
Old Corrugated Containers	3,254	3,558	3,511	3,796	4,244	5,138
News	1,995	2,198	2,073	2,040	2,118	2,384
Pulp Subst.	1,343	1,419	1,377	1,425	1,485	3,106
Deinking	500	552	493	502	464	
Mixed	3,130	3,212	3,140	3,237	3,392	3,272
Total Domestic	10,222	10,939	10,594	11,000	11,703	13,900
Exports	253	289	408	419	415	683
TOTAL	10,475	11,228	11,002	11,419	12,118	14,583

Source: Bureau of Census, U.S. Department of Commerce, Current Industrial Report Series M26A, "Pulp, Paper and Board" for 1968 to date; American Paper Institute, "Statistics of Paper and Paperboard," 1974 and American Paper Institute "Capacity Survey 1973 to 1976" for 1973 data.

TABLE V-3

COMPARISON OF U.S. CONSUMPTION AND RECOVERY RATES OF WASTE PAPER, 1968-1973

(thousands of short tons)

Year	Recovery of Waste Paper			Paper and Paperboard			
	Domestic Use (1)	Export (2)	Total (3)	Production (4)	Consumption (5)	Consumption Rate (%) (1) ÷ (4)	Recovery Rate (%) (3) ÷ (5)
1968	10,222	253	10,475	51,245	55,664	19.9	18.8
1969	10,939	289	11,228	54,187	58,915	20.2	19.0
1970	10,594	408	11,002	53,516	57,940	19.8	19.0
1971	11,000	419	11,419	55,092	59,558	20.0	19.4
1972	11,703	415	12,118	59,457	64,868	19.7	18.8
1973	13,900	683	14,583	61,830	67,241	22.5	21.7*

---

*Part of the significant jump in recovery rate shown for this year undoubtedly reflects the switch to API data sources.

Source: Bureau of Census, U.S. Department of Commerce, Current Report Series M26A "Pulp, Paper and Board" (Table S-1) for 1968 to 1972 data; "Statistics of Paper, 1974," American Paper Institute, for 1973 data. Calculations by Arthur D. Little, Inc.

TABLE V-4

ALLOCATION OF WASTE PAPER EXPORTED FROM THE UNITED STATES IN 1973
(thousands of short tons)

Point of Debarkation	Old Corr. Cont.	News	Pulp Subst. & Deinking	Total
Northeast	100	100	23	223
North Central	50	50	Negl.	100
South	10	10	Negl.	20
West Coast	90	90	160	340
Total	250	250	183	683

Source: Arthur D. Little, Inc., estimates based upon Census Bureau data and interviews with waste paper exporters.

C. DEFINITION OF PAPER STOCK CATEGORIES

1. PSI Listing

The Paper Stock Institute of America (PSI), a division of the National Association of Recycling Industries, Inc. (NARI), lists 46 regular grades and 26 "specialty" grades of waste paper stock. The regular grades comprise the major part of the waste paper market; the others are characterized by the presence of unusual contaminants, such as wet strength, polycoatings, plastic foil, carbon paper and hot-melt glue. While the specialty grades are produced and traded in carload and truckload quantities, the tonnages are relatively small and are not generally included with the reported statistics.

2. Consolidation of PSI List

One of the most comprehensive studies of waste paper usage was performed in 1970 by Professor W. S. McClenehan of the Institute of Paper Chemistry,* who compiled consumption data for each of the 46 major categories of paper stock and 4 special grades. The data represented actual 1969 consumption; figures for 1970 were projected on the basis of mid-year estimates. Respondents to the survey accounted for 90.8% of the total 11,969,000 tons used by the industry in 1969 and thus provided a sound data base.

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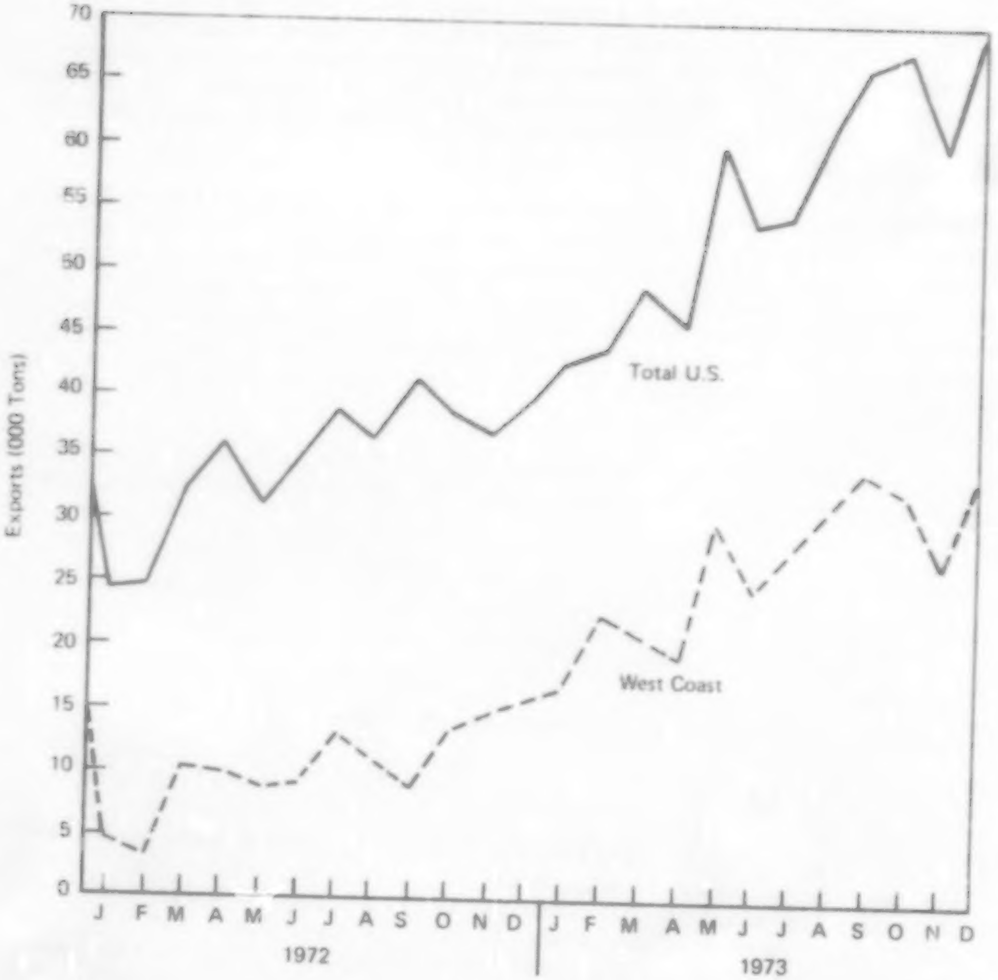
*W.S. McClenehan, Consumption of Paper Stock by U.S. Mills in 1969 and 1970, Div. of Information Services, The Institute of Paper Chemistry, Appleton, Wisconsin, 1971.



Source: U.S. Census Bureau and Paper Stock Conservation Committee, American Paper Institute, February 1974

FIGURE V–3 MONTHLY U.S. WASTE PAPER EXPORTS, 1972–1973

Unlike the detailed list used by PSI to define the various grades, the Bureau of Census used only five major categories in reporting consumption. Hence, although more detailed consumption data are available, usage patterns are most conveniently discussed in accordance with the five classes recognized by the Bureau of Census.

As no official relationship exists between the Census and PSI breakdowns, we have combined them in Table V-5 in a manner suggested by McClenehan. We have also postulated an apportionment of the grades between pre-consumer and post-consumer sources.* The data are for 1970 only, but the grouping of grades by major categories is applicable to more recent data.

With minor exceptions, all the individual paper stock grades that make up the OCC, news, pulp substitute, and deinking categories are derived from specific paper/paperboard grades identified by API. In the mixed paper category, however, the origin of the constituent materials is lost in the all-inclusive terms of "mixed," "cuttings," and "mill wrappers." To be consistent and to complete our analysis of the recyclability of the individual paper grades, we had to postulate the composition of this category.

Discussions with a number of waste paper dealers indicated that "mixed paper" is generally office waste with the following approximate composition:

	Range (%)	Typical Percentage
OCC	0-15	5
News	10-25	15
High-Grade Printing and Writing	90-60	80

---

* Pre-consumer waste is waste paper that is generated before the intended end use of the paper or paperboard packaging material—e.g., printing or converting plant waste. (The terms "pre-consumer waste" and "converter waste" have been used synonymously in this analysis.)
Post-consumer waste is that generated after the intended end use. It includes commercial and industrial waste as well as household waste. Some grades, such as over-issue news, can be either pre- or post-consumer waste: newspapers that never leave the printing plant are normally considered pre-consumer, while those that are returned unsold from the dealers are considered post-consumer.

TABLE V-5

PAPER STOCK CONSUMPTION, 1970
(thou and tons)

	Converter Waste[a]	Post-Consumer Waste[a]	Total
OLD CORRUGATED CONTAINERS (OCC)			
Solid fiber containers		34	
Corrugated containers		2,645	
New corrugated cuttings	357		
New double kraft lined corr. cuttings	1,096		
New brown kraft corrugated cuttings	99		
TOTAL OCC	1,552	2,679	4,231
NEWS			
No. 1 news		1,338	
Super news		551	
Over-issue news		151	
No. 1 groundwood shavings	87		
TOTAL NEWS	87	2,040	2,127
PULP SUBSTITUTE (P/S)			
No. 1 used brown kraft bags		19	
Mixed kraft bags		12	
No. 1 brown kraft paper		29	
Super sorted brown kraft		11	
New colored kraft	14		
New brown kraft cuttings	51		
New brown kraft bag waste	47		
New brown kraft envelope cuttings	36		
Mixed shavings	201		
White newsblanks	116		
Super white newsblanks	15		
Publication blanks	66		
No. 1 flyleaf shavings	96		
No. 1 soft white shavings	81		
Super soft white shavings	16		
Hard white shavings	57		
Hard white envelope cuttings	103		
Super hard white envelope cuttings	15		
New colored envelope cuttings	32		
Semi-bleached envelope cuttings	16		
Super semi-bleached cuttings	28		
Manila tabulating cards		199	
Unprinted bleached sulphate	238		
Converting plant trim and miscellaneous[c]	358[b]		
Kraft side rolls and boxes[c]	58		
News side rolls[c]	9		
TOTAL P/S	1,653	270	1,923

(Continued)

TABLE V-5 (continued)

PAPER STOCK CONSUMPTION, 1970
(thousand tons)

	Converter Waste[a]	Post-Consumer Waste[a]	Total
DE-INKING (DI)			
No. 1 sorted colored ledger		78	
Super colored ledger		137	
No. 1 sorted white ledger[d]		212	
Super white ledger[d]		40	
Colored tabulating cards[d]		63	
No. 1 graded magazines		34	
No. 1 book stock		64	
Printed bleached sulphate cuttings	112		
Misprint bleached sulphate	53		
Polyethylene or wax coated stock[c]	201		
TOTAL DI	366	628	994
MIXED			
No. 2 mixed paper		424[e]	
No. 1 mixed paper		1,142[e]	
Super mixed paper		246[e]	
Boxboard cuttings	733		
Mill wrappers		6	
TOTAL MIXED	733	1,818	2,551
TOTAL ALL CATEGORIES	4,391	7,435	11,826

---

[a] Partially estimated by respondents and author

[b] Includes an unknown amount of post-consumer waste

[c] Grades not defined by Paper Stock Institute

[d] Can be used as P/S

[e] Includes an unknown amount of converter waste

Source: Grouping of grades into five major categories by W.S. McClenehan; distribution between converter and post-consumer origin is ADL estimate.

For purposes of our overall material balance, we used about the midpoint of the range reported.

D. SOURCES OF MAJOR WASTE PAPER CATEGORIES

An analysis of the data indicates that OCC is by far the single largest component of waste paper used by the industry and that about 63% of the waste paper originates from post-consumer waste (Figure V-4). We must look to post-consumer sources for any substantial increase in the supply of waste paper, as the potential for increasing the availability of converter waste is limited.

A further analysis of the information developed by McClenehan reveals that the East North Central is by far the single largest user of waste paper, both in tonnage (Table V-6) and as a percentage of the region's total papermaking capacity (Figure V-5). Note the unusually high consumption of pulp-substitute and deinking grades in this region; this reflects the large number of nonintegrated manufacturers of tissue and printing and writing papers there.

Further information on usage patterns and opportunities for increasing the supply of waste paper by region is given in Section VI.

The specific origin of waste paper strongly influences the possibility of its increased availability, the cost of collection, and the channels of recovery. The following are nine principal sources of this material:*

Residences or households

Institutions

Office buildings

Retail establishments

Wholesale establishments

The transportation industry

Printing and converting industries

Service industries

Other industrial and commercial sectors

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* Battelle Memorial Institute, op. cit., Vol. III

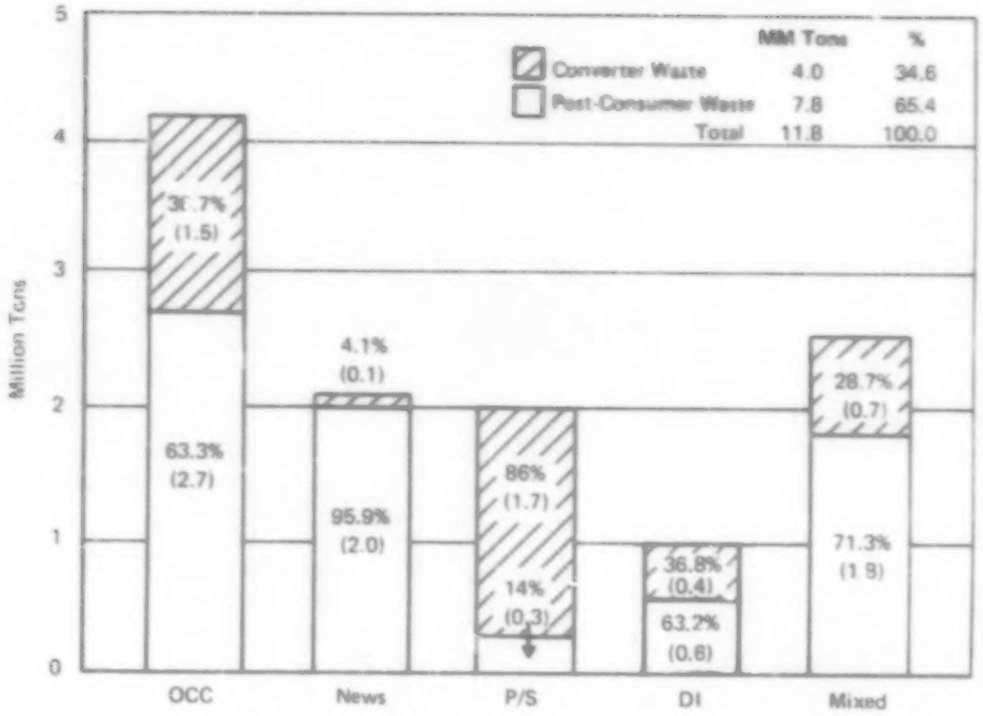


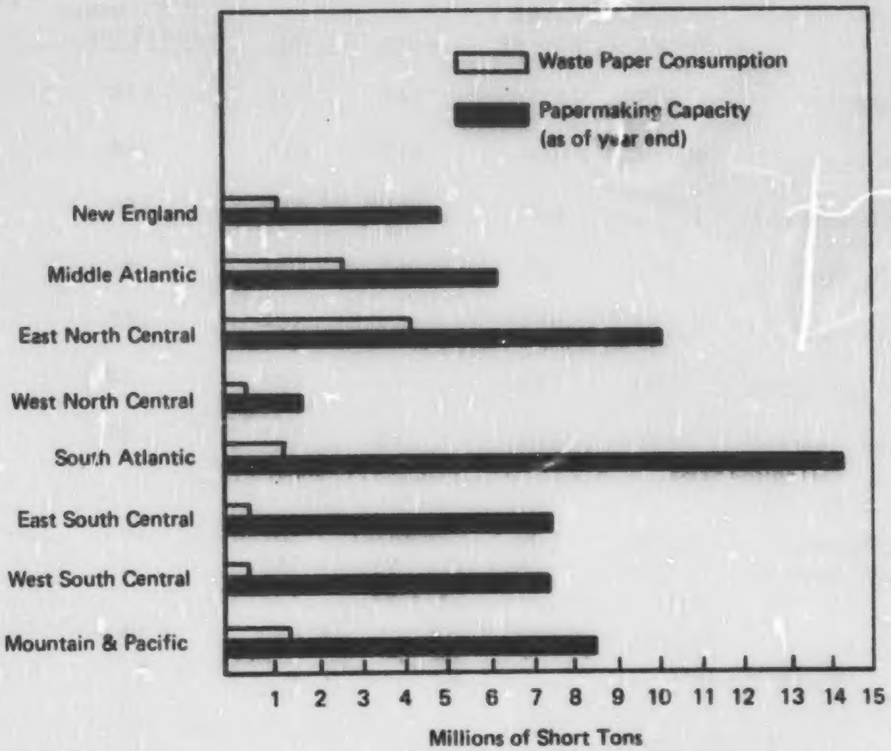
FIGURE V-4 ESTIMATED SUPPLY OF CONVERTER AND POST-CONSUMER WASTE PAPER (1970)

TABLE V-6

ESTIMATED U.S. CONSUMPTION OF WASTE PAPER BY GRADE AND REGION, 1970
(thousands of short tons)

	Total	Mixed Papers	News	OCC	Pulp Subst. & High-grade Deinking
New England	1,093	172	144	301	476
Middle Atlantic	2,805	606	617	816	766
East North Central	4,053	837	739	1,311	1,166
West North Central	352	105	64	136	47
South Atlantic	1,188	255	169	557	207
East South Central	503	122	71	226	84
West South Central	551	195	88	188	80
Mountain & Pacific					
California	1,138	268	293	387	190
Other states	338	79	50	158	51
TOTAL U.S.	12,021	2,639	2,235	4,080	3,067

Source: McClenehan, op. cit.



Source: Capacity Survey, American Paper Institute

FIGURE V–5 WASTE PAPER CONSUMPTION AND PAPERMAKING CAPACITY (1971)

The relationship between these sources and the five categories of waste paper used by the Bureau of Census is as follows:

(1) Old corrugated containers (OCC)* are primarily generated (i.e., discarded) by retail and wholesale establishments and by other industrial and commercial sectors; relatively small quantities come from the residential or household sector.

(2) Old newspaper ("news")* is generated by all nine sectors, but households are by far the primary source. A recent study by the Forest Products Laboratories** indicated that newspaper comprised about 40% of the paper in household trash (Table V-7) and that the 78 pounds discarded per person per year corresponded to about 80% of the total amount of newspaper printed.

Obviously, the quantity of newsprint in household trash is influenced by the effectiveness of old news collection systems within a given area. At the time of the survey, news was not collected separately from other household trash; accordingly, the study provides valuable insight as to the point of origin of this important paper stock grade.

(3) Pulp substitutes (P/S) are generated principally by the printing and converting sector. The homogeneous form and high quality of paper stock grades in this category enable them to command a premium price.

(4) Deinking (DI) is generated in all sectors, but principally by offices, institutions, and other industrial and commercial sectors.

(5) Mixed papers are generated in all sectors, but traditionally have been collected primarily from offices, institutions, and other commercial and industrial sectors.

In summary, with the exception of newsprint, commercial and industrial sources constitute the most promising area for the recovery of high-quality waste paper. A large quantity of all paper and paperboard products consumed are discarded by commercial/industrial sources, and their discards tend to be more homogeneous and of higher value than household discards.

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* Although the names of these categories imply post-consumer waste, they also contain some converter waste, as shown in Table V-5. OCC, for example, contains roughly 35% new corrugated cuttings.

**G.C. Myers, Paper Trade Journal, Vol. 155, No. 35 (1971) 32.

TABLE V-7

ANNUAL PER CAPITA CONSUMPTION AND DISCARDS OF PAPER

Product	Consumption[a] (lb)	Household[b] Discards (lb)
Newsprint	87	78[c]
Groundwood paper	10	2
Book paper	48	24
Fine paper	23	8
Coarse-industrial paper	58	25
Sanitary and tissue	31	15
Construction	15	-
Container board	183	11
Bending board	64	32
Building board	26	-
Other board	30	-
Total	575	195[d]

---

[a] Average U.S. per capita in 1969

[b] Based on discards from Madison, Wisconsin households in April 1970

[c] At time of survey, the recycle ratio for newsprint in Madison was about 7%

[d] Equivalent to 34% of the total paper consumption

Source: G.C. Myers, op. cit.

E. SUPPLIERS

As illustrated in Figure V-6, waste paper flows through a variety of channels to reach its ultimate point of use at the consuming mill. While these routes are not clearly defined, certain patterns are characteristic of the point of origin particular to each of the major grades. Some of the individuals and organizations that handle this material on its way to the mill are described below.

Waste paper dealers buy paper stock from scavengers, solid-waste collectors, converters, and other public or commercial sources. They usually have sorting and baling facilities and sell directly to a consuming mill or to a broker. A dealer may process all five major categories of waste paper, but normally each facility is organized to handle either the bulk grades (OCC, news, and mixed) or the high-added-value grades (P/S and DI).

At one time, most waste paper dealers were independent, family-owned businesses; more recently, however, many have been acquired by major solid-waste management organizations or have become affiliated with a consuming mill.

The scavenger collects and/or buys paper and various other secondary materials and sells them to a dealer, broker, or in some instances, directly to a consuming mill. Most scavengers deal primarily with the bulk grades--OCC, news, and mixed papers--and have baling equipment to facilitate its transport to the next point in the supply channel.

Brokers buy paper stock from scavengers, solid-waste collectors, converters, and other public or commercial sources. Typically, they do not have sorting or baling facilities; rather, they act as general contractors who take on the responsibility of identifying and organizing a number of small suppliers to meet the needs of a consuming mill. Alternatively, a broker may provide this service and sell (or exchange) his paper stock to another broker or to a dealer. These processors handle all grades but rarely deal in mixed paper.

Solid-waste collectors or solid-waste managers are public or private organizations that collect municipal solid waste, reclaim the paper stock, and sell it directly to consuming mills, waste paper dealers, or brokers. Browning-Ferris Industries (BFI) and SCA are two of the largest firms of this kind. BFI, through an affiliate, Consolidated Fibres, is integrated to a major waste paper dealer and to numerous scavengers throughout the country. The other large waste-management firms are similarly structured to collect municipal (or industrial) solid waste and to sell the reclaimed paper stock directly to consuming mills. These processors deal primarily with the bulk grades.

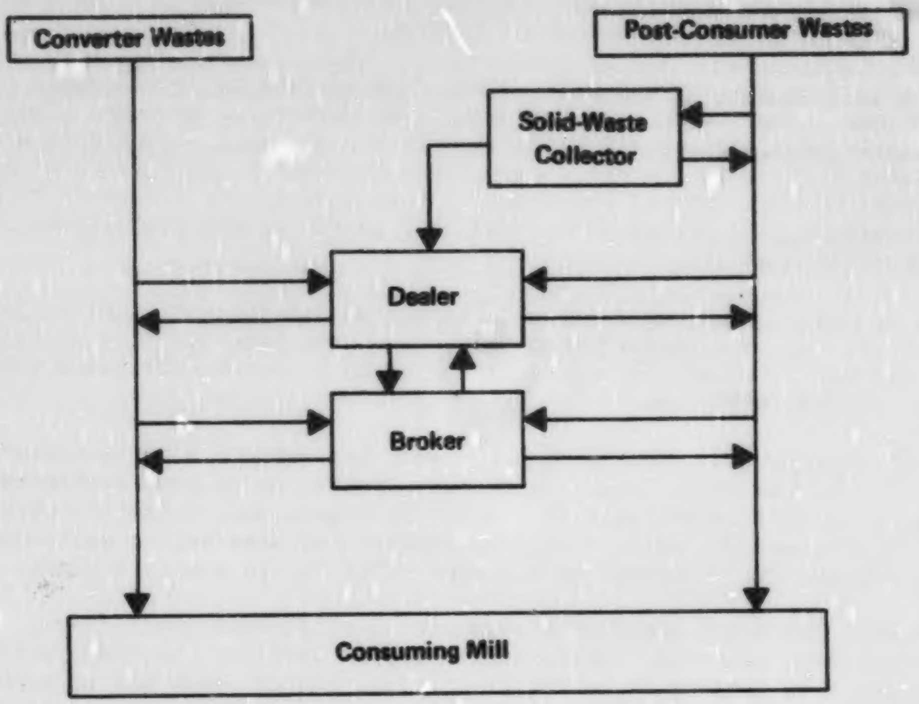
Converter Wastes
Post-Consumer Wastes
Solid-Waste Collector
Dealer
Broker
Consuming Mill

FIGURE V–6 FLOW OF WASTE PAPER FROM POINT OF ORIGIN TO CONSUMING MILL

Waste paper is also collected by charitable groups (social and religious organizations). Their activities are generally limited to collecting old news from the residential sector and selling it, unbaled, to a consuming mill, scavenger, or waste paper dealer. In the past, these groups were a major factor in the supply of waste news, but their importance is declining as more municipalities are organizing their trash collection system so that waste news is picked up separately or along with the household trash.

F. STRUCTURE OF THE INDUSTRY

In 1970, there were about 1300 waste paper dealers in the United States. Table V-8 shows their regional distribution and estimates of the annual tonnage handled by the average dealer in each region. The largest dealer establishments are in California and in the East North Central and East South Central regions because of the large quantity of waste paper historically used in these regions.

By any comparative standard this industry is extremely fragmented with many small, family-operated firms. On the other hand, there is a fair degree of concentration at the top: from information reported in the U.S. Census of Wholesale Trade, we estimate that the 100 largest establishments account for about half of the industry's sales, averaging roughly $3 million in sales per establishment. Using typical selling prices for paper stock prevailing in 1974 and the reported capacities of the firms, we derived annual sales of an average dealer at about $400,000 to $500,000.

Table V-9 lists the 17 largest paper stock companies and indicates captive affiliations with paper companies. We believe that each of the firms in this group has sales of over $5 million per year. Table V-10 lists the second-tier paper stock dealers and their paper company affiliations; we estimate that most of the firms in this group have annual sales of $2-5 million.

There has been a gradual trend over the past ten years for large waste paper consumers to acquire dealers who essentially act as collectors and purchasing agents for the mills. With the expected stimulation of recycling activity, we expect this trend to accelerate. We also expect a greater incidence of direct supply relationships between big converters and large generators of waste paper and the paper mills. The underlying cause of these trends will be the paper mills' desire to assure their supply of raw material and thus reduce their risks.

On the other hand, increasing use of captive dealers and direct supply relationships with converters by the paper mills does not preclude purchases from other dealers, who may be in a better position to provide certain grades of waste paper to fill out their supply.

Within the last few years, the structure of the waste paper industry has changed significantly. As demand has risen, more of the large generators are bypassing the dealers and negotiating directly with consuming mills. Collection systems operated by towns and cities, which are becoming an integral part of the supply channel, are doing the same thing. To assure themselves of a continuing supply, an increasing number of mills have also become affiliated with waste paper dealers or have established their own dealers.

A third major change is the acquisition of small, independent dealers by major solid-waste management firms. Browning-Ferris Industries alone, through its subsidiary, Consolidated Fibres, has expanded and consolidated its position in the past 2 1/2 years by growing from 11 facilities in 5 states to 41 in 20 states, the District of Columbia, and two Canadian provinces.* The firm is shipping papermaking fiber at an annual rate above two million tons.

The acquisition of waste paper dealers by BFI and others has been prompted by their need to secure market outlets. Since a large fraction by weight of the solid waste collected is paper, forward integration by these firms into waste paper sales is a logical step and could lead to greater stability in the cost and availability of secondary fiber.

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* Official Board Markets, Vol. 50, No. 52 (Dec. 28, 1974), 9.

TABLE V-8

NUMBER OF DEALERS AND AVERAGE SIZE BY REGION-1970

Region	Number of Dealers	Regional Demand (000 tons/yr)	Average per Dealer[a] (000 tons/yr)
New England	154	1,093	4.7
Middle Atlantic	524	2,805	3.6
East North Central	256	4,053	10.6
West North Central	77	352	3.1
South Atlantic	121	1,188	6.6
East South Central	37	503	9.1
West South Central	57	551	6.4
Mountain and Pacific			
California	69	1,138	11.0
Other States	42	338	5.4
TOTAL	1,338	12,021	6.0

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[a] Calculated by dividing regional demand by number of dealers and multiplying by two thirds. According to McClenehan (op.cit.), only about two thirds of all waste paper goes through dealers.

Sources: Col. 2 - Paper Stock Dealers Directory, Fiber Market News, 1970
Col. 3 - American Paper Institute
Col. 4 - Calculated by Arthur D. Little, Inc.

TABLE V-9

LARGEST PAPER STOCK DEALERS

Company	Key Locations	Affiliations and Comments
D. Benedetto Inc.	New York, Buffalo, Elkhart (Ind.), Toronto	Canadian operations half owned by Continental Can
Consolidated Paper Grading Company	Chicago	
Consolidated Fibres, Inc.	New York, Calif., Oregon, Arizona	Merged with Browning-Ferris Industries
Derrico Company, Inc.	New York	Affiliated with Whippany Paperboard Company
Federal Paper Stock Co.	St. Louis	
Fibre Core, Inc.	New York	
Friedman & Sons, Inc.	Denver and other cities	
Great Eastern Packing & Paper Stock Corp.	New York, New Jersey, Boston	Has 50% interest in Garden State Fiber Co., Pomona, Cal.
Independent Paper Stock Co.	California, Oregon	Wholly owned by Fibreboard Paper Products Corp.
International Cellulose	Chicago	Specializes in large printing plant waste
Letellier-Phillips Paper Co.	New Orleans	
National Fiber Supply Co.	Chicago	No sorting plant
Packaging Corp. of America	Cleveland, Kansas City (Mo.)	Totally captive
Paper Reclamation Div.	St. Louis, Kansas City (Mo.)	Wholly owned by Alton Box Board
Pioneer Paper Stock Div.	Chicago	Wholly owned by Container Corp.
I.V. Sutphin Co.	Cincinnati, Atlanta, Augusta (Ga.), Charlotte (N.C.), Columbia (Miss.), Jacksonville, Nashville	
Toga Paper Stock Co.	New Jersey	Wholly owned by Federal Paper Board - one small plant

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Sources: Paper Stock Institute of America and Consolidated Fibers, Inc.

TABLE V-10

SECOND-TIER PAPER STOCK DEALERS

Company	Key Location	Affiliation and Comments
Acme Paper Stock Co.	Louisville, Ky.	
American Paper Stock Co.	Indianapolis, Ind.	Owned by Scott Paper
Arco Trading Corp.	Pittsburgh, Pa.	No plant
Atlantic Paper Stock Co.	Baltimore, Md. Norfolk, Va.	
N. Bantivoglio's Sons Inc.	Camden, N.J.	
Batliner Paper Stock Co.	Kansas City, Kans.	
Bel-Art Paper Stock Co.	Los Angeles, Calif.	
Bruno & D'Elia Inc.	New York, New Jersey	Supply Garden State Paper Co.
Byerly & Infante Inc.	Philadelphia, Pa.	No plant
Capital Reclamation Corp.	Washington, D.C	
Castle & Overton	New York, N.Y.	Owned by Perkins-Goodwin; no plant
Commercial Waste Paper Co.	Milwaukee, Wis.	
The Dayton Paper Stock Co.	Dayton, Ohio	Owned by Diamond National; Plant closed
Durbin Paper Stock Co.	Miami, Fla.	
G. H. Einhauser Co.	Pittsburgh, Pa.	
Empire Waste & Metal Corp.	Utica, N.Y.	
Fibers, Inc.	Chicago, Ill.	No plant
Florida Rag Co.	Miami, Fla.	
Gaccione Co.	Lyndhurst, N.J.	
Garden State Fiber Co.	Pomona, Calif.	Owned by Garden State Paper Co.; no plant

(Continued)

TABLE V-10 (Continued)

SECOND-TIER PAPER STOCK DEALERS

Company	Key Location	Affiliation and Comments
General Mill Supply Co.	Detroit, Mich.	
Glove Co., Inc.	New York, New Jersey	Specializes in high grades
Goldman Paper Stock Co.	Richmond, Va.	
Wm. Goodman & Sons, Inc.	Portland, Me.	
Gordon Waste Co.	Columbia, Pa.	Also handles metals
Great Lakes Paper Stock Corp.	Buffalo, N.Y.	Subsidiary of D. Benedetto
Grossman & Sons, Inc.	Columbus, Ohio	
Hancock Paper Co.	Philadelphia, Pa.	
I. Hershman	New Haven, Conn.	
Hicks-Costarino Co., Inc.	Maspeth, LI, N.Y.	
Hoerner Waldorf	Minneapolis, Minn.	Captive dealer
Kline Paper Stock Co.	Washington, D.C.	
Perry H. Koplik & Sons, Inc.	New York,N.Y.	No plant, primarily pulp
Lehigh Waste Materials Co.	Philadelphia, Pa.	
Lissner Corp.	Chicago, Ill.	
Marcus Paper Company	Westhaven, Conn.	
Marks Paper Stock Co.	Canton, Ohio	
Monroe Scrap Material Co.	Monroe, Mich.	Also handles metals
Mustang Waste Paper Co.	Houston, Texas	
North American Paper Co.	Columbus, Ohio	
North Shore Waste Paper Co.	Salem, Mass.	
Louis Padnos Iron & Metal Co.	Holland, Mich.	Metal and paper
Paper Products Inc.	Trenton, N.J.	
Paper Stock Dealers, Inc.	Carolinas	Captive dealer, owned by Sonoco

(Continued)

TABLE V-10 (Continued)

SECOND-TIER PAPER STOCK DEALERS

Company	Key Location	Affiliation and comments
Herman Petricoff & Co.	Cincinnati, Ohio	
Ponte Brothers, Inc.	New Jersey	
Riverside Industries, Inc.	Bettendorf, Iowa	
Royal Paper Stock Co.	Columbus, Ohio	
Ed Sacks Co.	Houston, Texas	
Sangamon Paper Grading Co.	Chicago, Ill.	
P. Shaffer Co.	Chelsea, Mass.	
Sims Paper Stock Co.	Birmingham, Ala.	
J. Solotken & Co.	Indianapolis, Ind.	
Southern Waste Paper Co.	Spartanburg, S.C. Greensboro, N.C.	Mill owned
Tennessee Paper Co.	Atlanta, Ga. Knoxville, Tenn.	
Union Salvage Co.	Plainfield, N.J.	
United Paper Stock Co.	Providence, R.I.	
United Waste Material Co.	Los Angeles, Calif.	
Universal By-Products, Inc.	Los Angeles, Calif.	
Waste Papers Inc.	Garfield, N. J.	Owned by Garden State, no plant
Winter Paper Stock Co., Inc.	Cleveland, Ohio	
Howard Zuker Associates	Chicago, Ill.	No plant

Sources: Paper Stock Institute of America and Consolidated Fibers, Inc.

VI. WASTE PAPER COSTS

This section deals with the major costs of collecting, processing, and transporting waste paper from the point of origin to a paper mill. The analysis is based on both published and unpublished information obtained in interviews with selected waste paper dealers, trade associations, scavengers, and public officials responsible for solid-waste disposal.

A. HISTORICAL PRICES

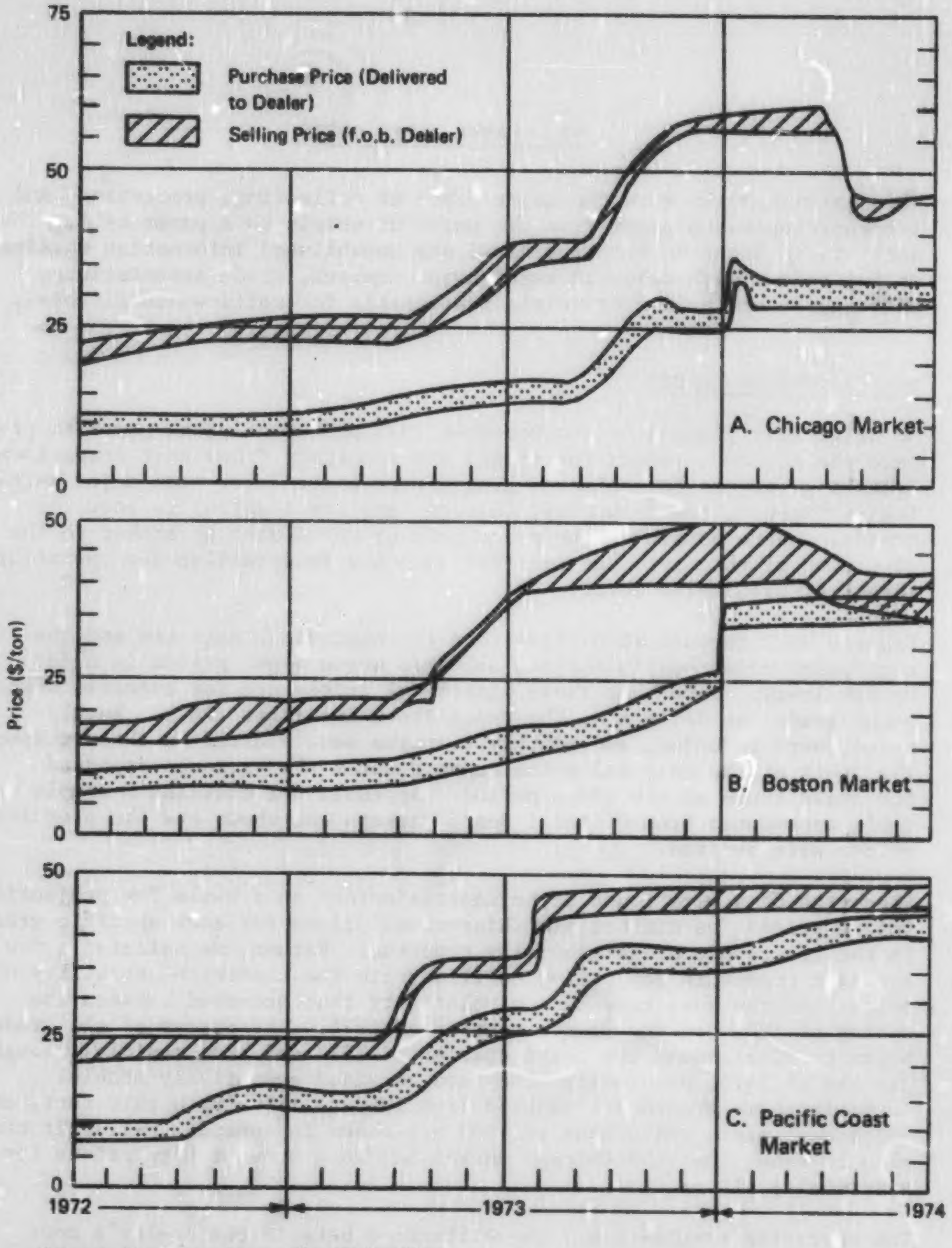
We originally planned to use December 1973 prices of waste paper to prepare the economic models for virgin and secondary fiber cost comparisons. Historical prices for selected grades were plotted for each major market region (Boston, New York City, Chicago, and Los Angeles) to show the trends. Where possible, the price paid by the dealer or broker to the generator of the waste was recorded in order to establish the operating margin at the dealer level.

Figures VI-1 through VI-6 illustrate the historical patterns and the cost/price relationship for the selected waste paper grades in major market areas. Note that these historical prices are for specific waste paper grades as defined by the Paper Stock Institute (PSI). Weekly prices were recorded, and monthly averages were plotted in these graphs. The width of the cost and price bands denotes the variance reported for these items at any given period. Appendix C-1 contains a sample table reproduced from Official Board Markets and shows how the plotting points were derived.

Since the data were found to be unsatisfactory as a basis for projecting future prices, we did not plot historical prices for each specific grade in the geographic areas generally reported. Rather, we selected a few specific grades in key cities to illustrate the historical stability of prices and the more recent high volatility that occurred between the spring of 1973 and the fourth quarter of 1974. The prices of all grades began to rise around the third quarter of 1972 and rose rapidly through the end of 1973; previously, they had remained essentially stable. (Data for some grades are plotted from 1969 to illustrate this fact, and additional plots going back to 1967 are shown in Appendix C-1.) It can also be seen that the Chicago market has long brought high prices for practically all grades.

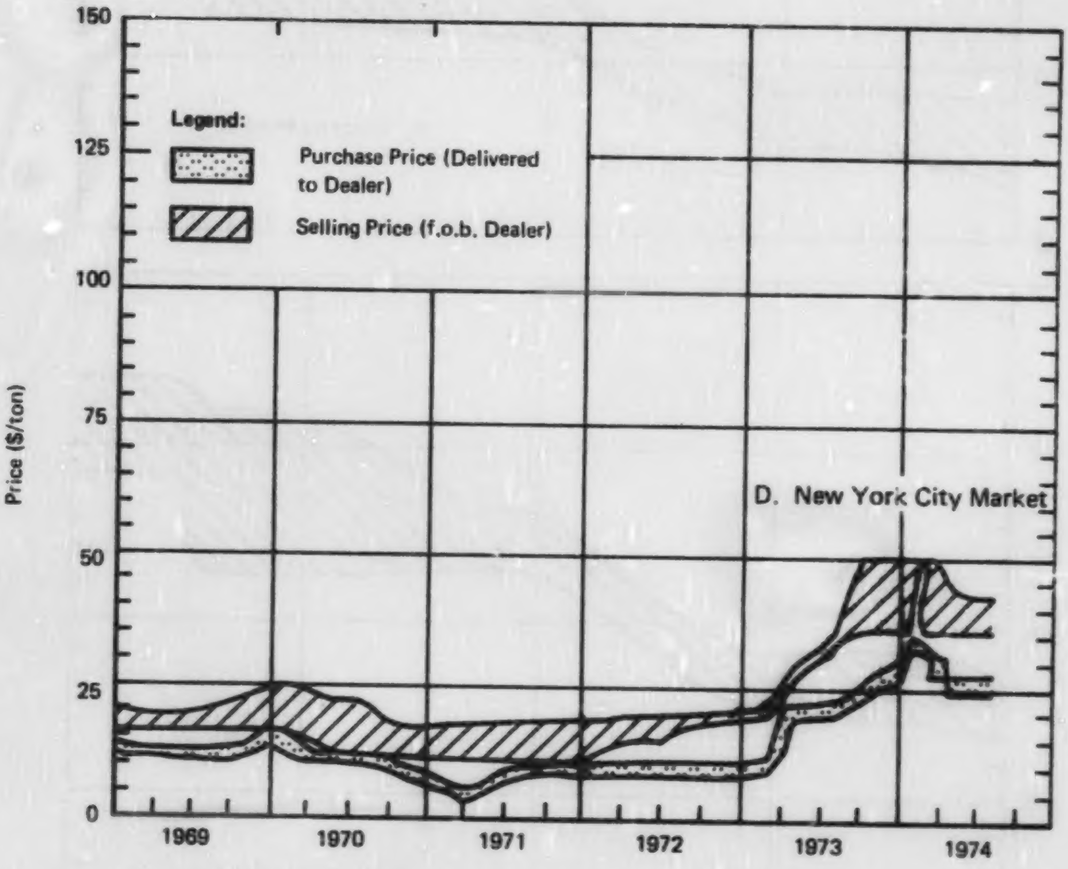
The operating margin--i.e., the difference between the dealer's cost and dealer's selling price, from which the dealer must deduct his operating cost to arrive at a profit margin--is typically greater for the higher-added-value P/S and high-grade deinking grade (e.g., white ledger) than it is for the lower-added-value grades (e.g., mixed paper). This is because high-grade waste paper costs the dealer more to sort,

(continued on page VI-13)



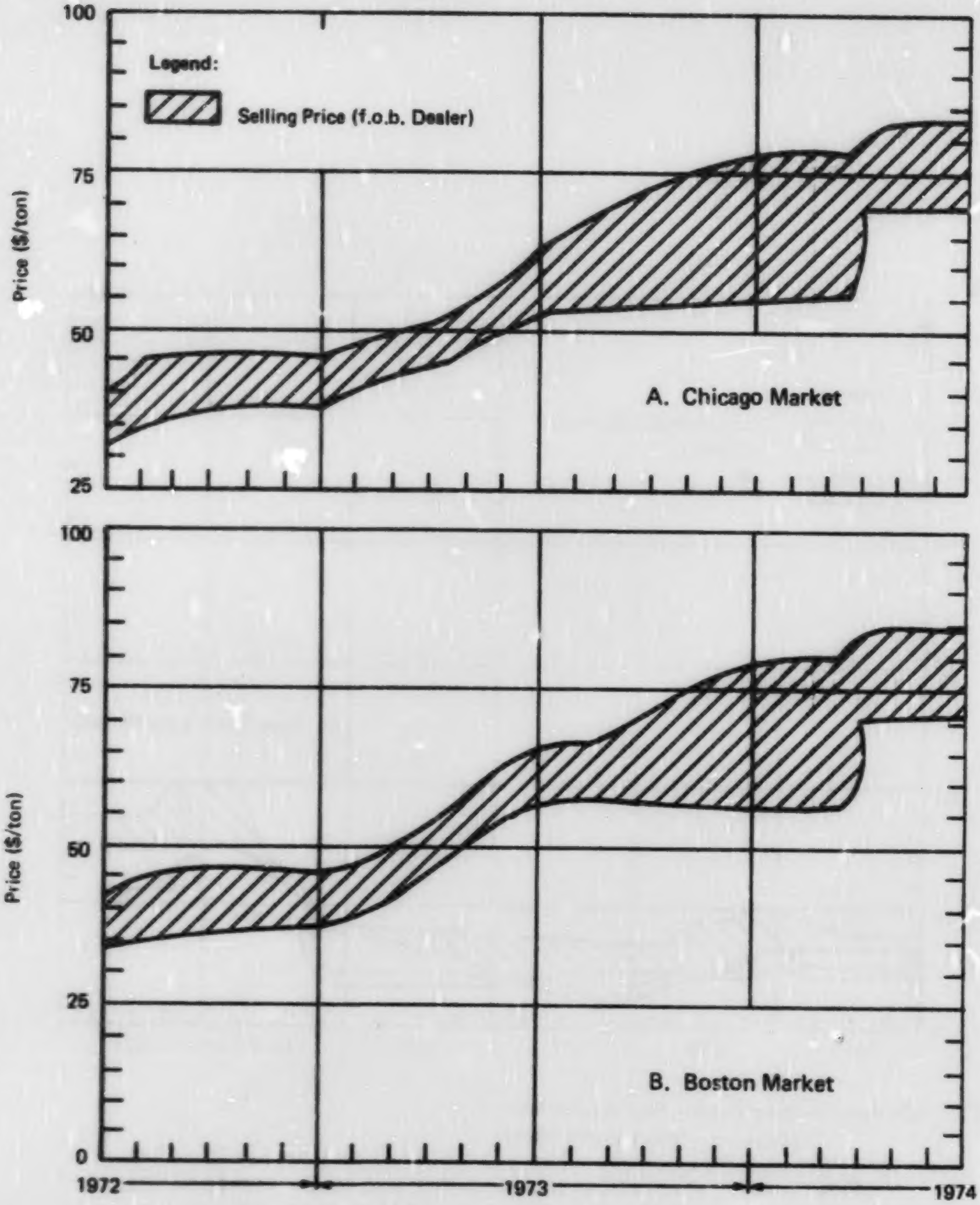
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–1 DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – CORRUGATED CONTAINERS



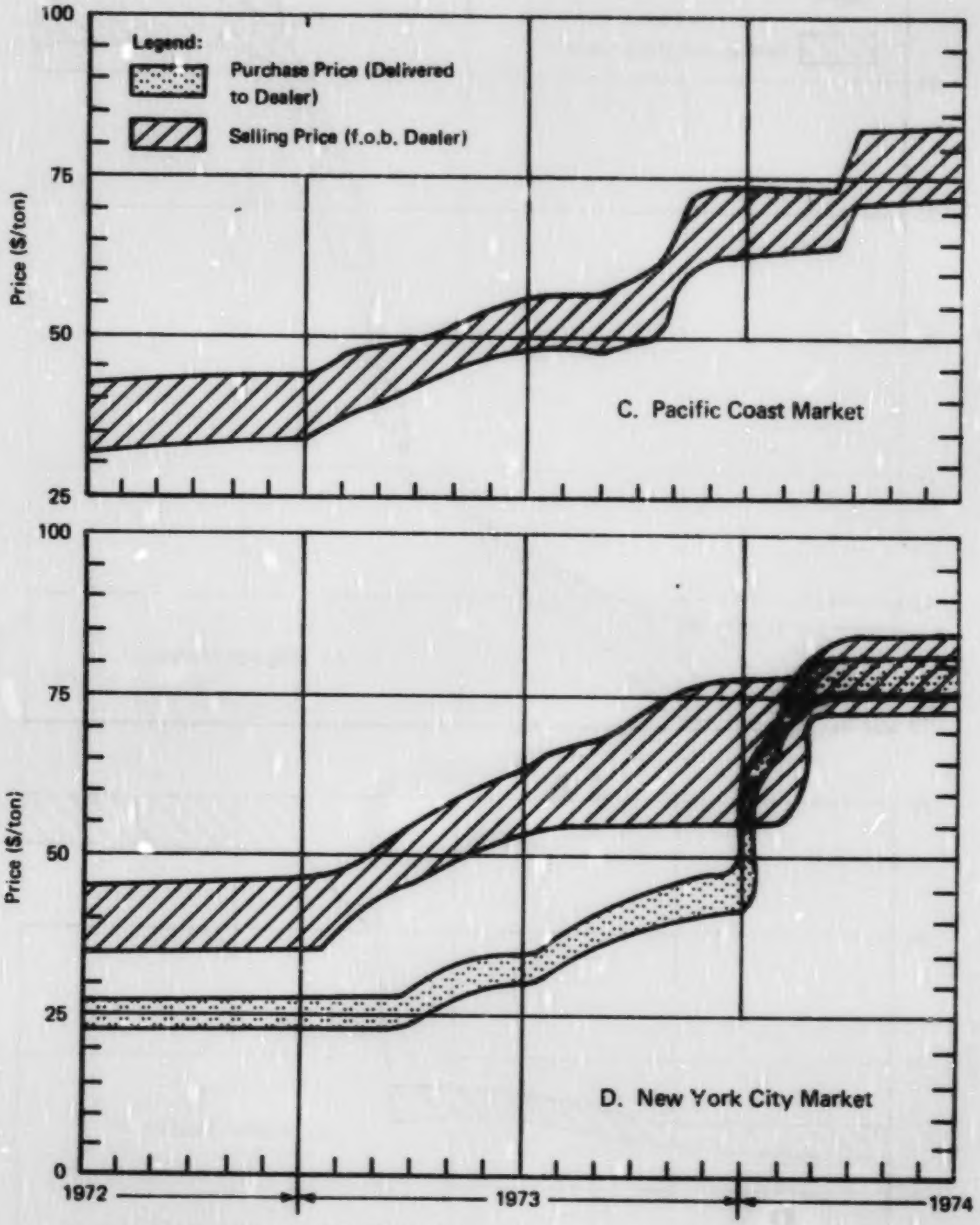
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–1 (Cont'd) DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – CORRUGATED CONTAINERS



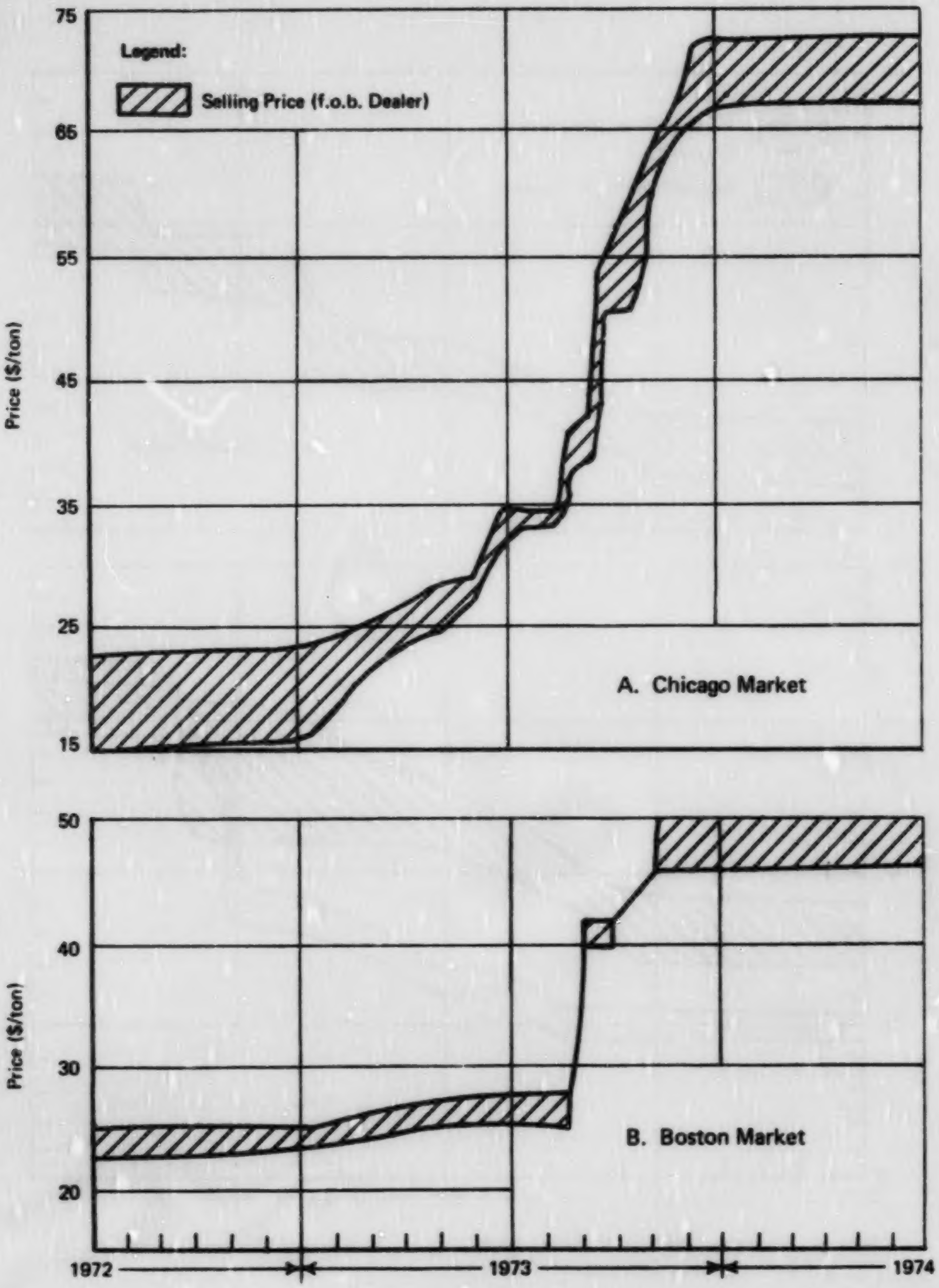
Source: *Official Board Market*

FIGURE VI–2 DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – NEW DBL. KRAFT LINED CORR. CUTS, SEMICHEM.



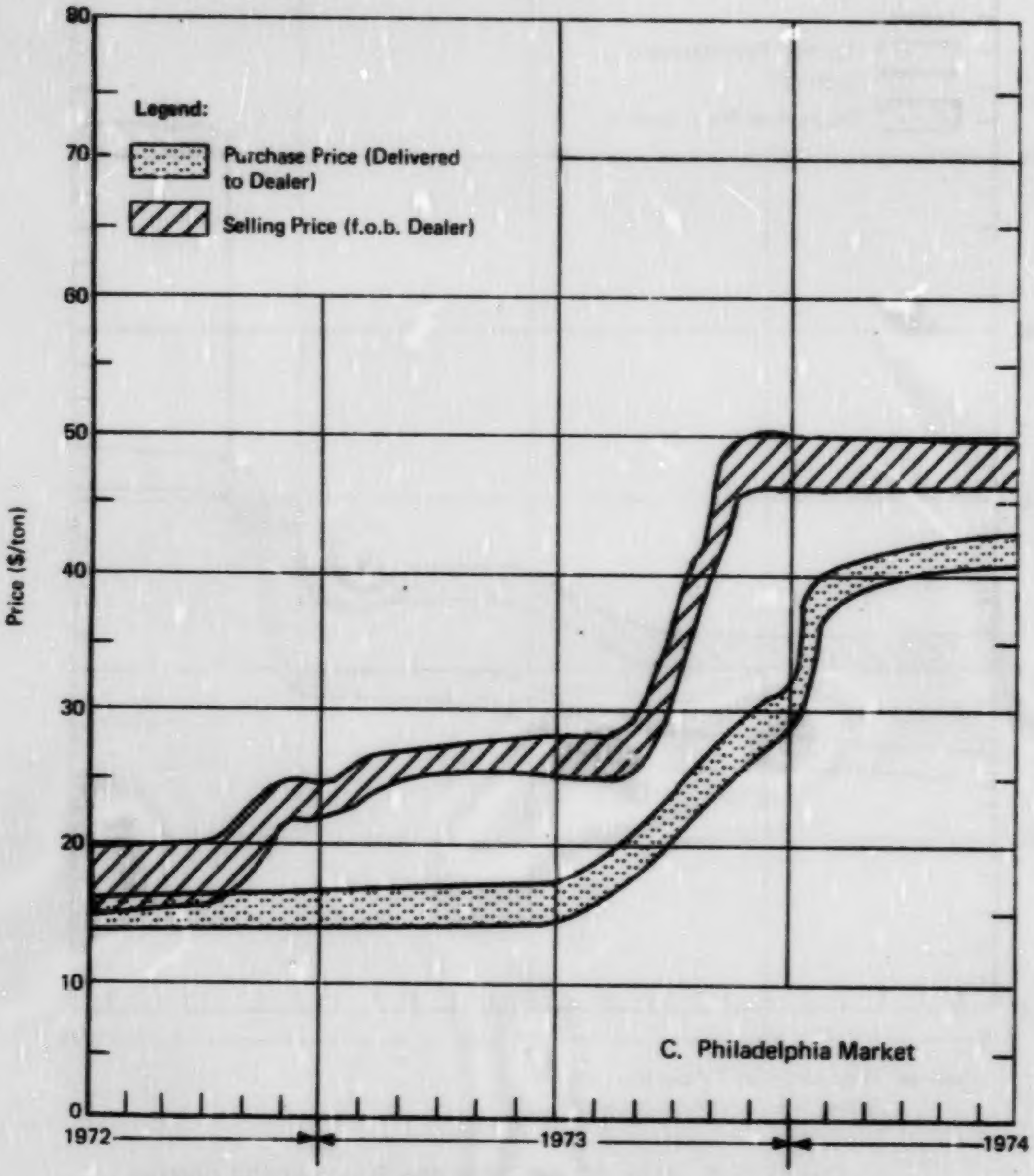
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–2 (Cont'd.) DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – NEW DBL. KRAFT CORR. CUTS, SEMICHEM.



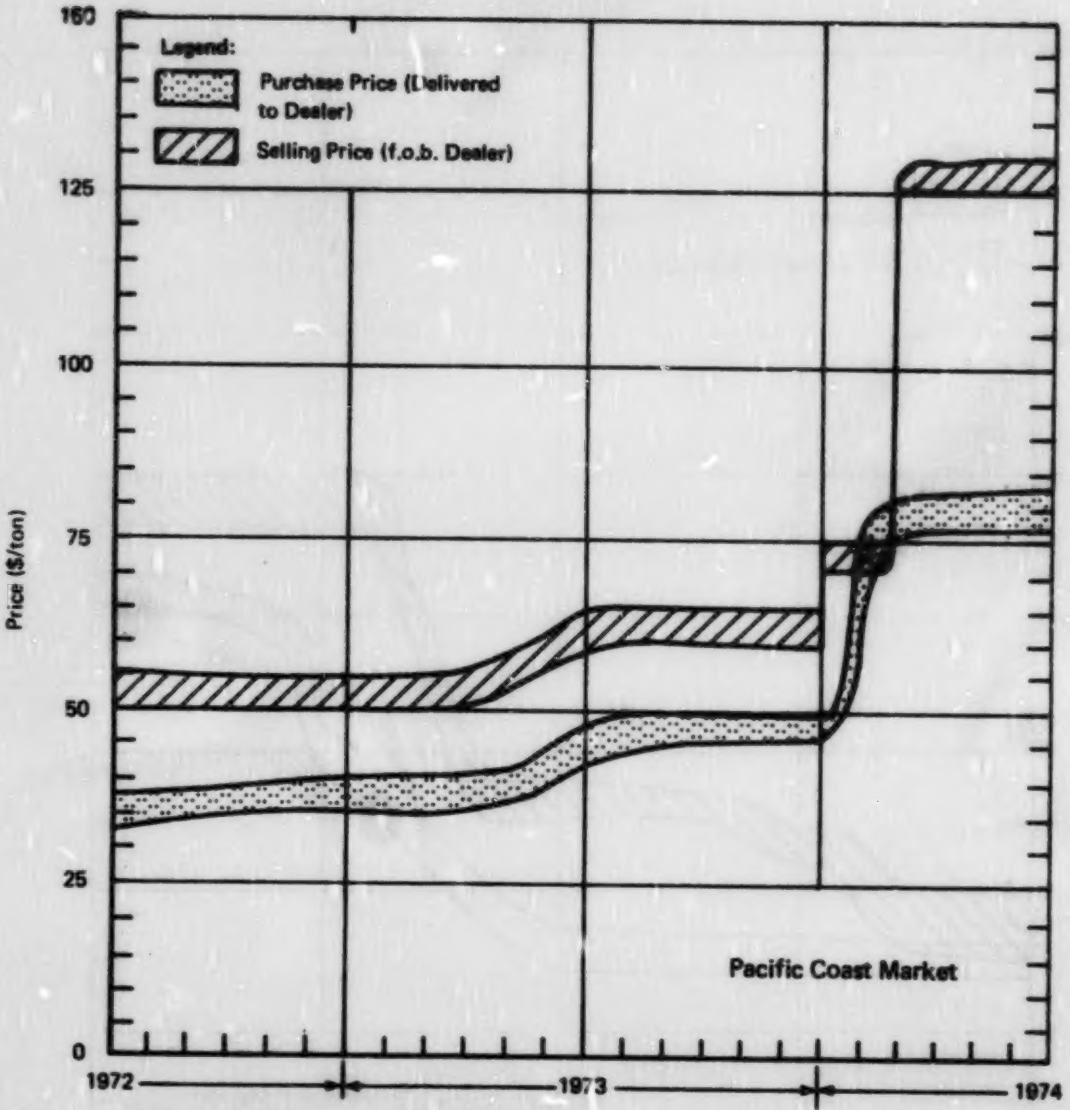
Source: *Official Board Market*

FIGURE VI-3 DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – NO. 1 NEWS



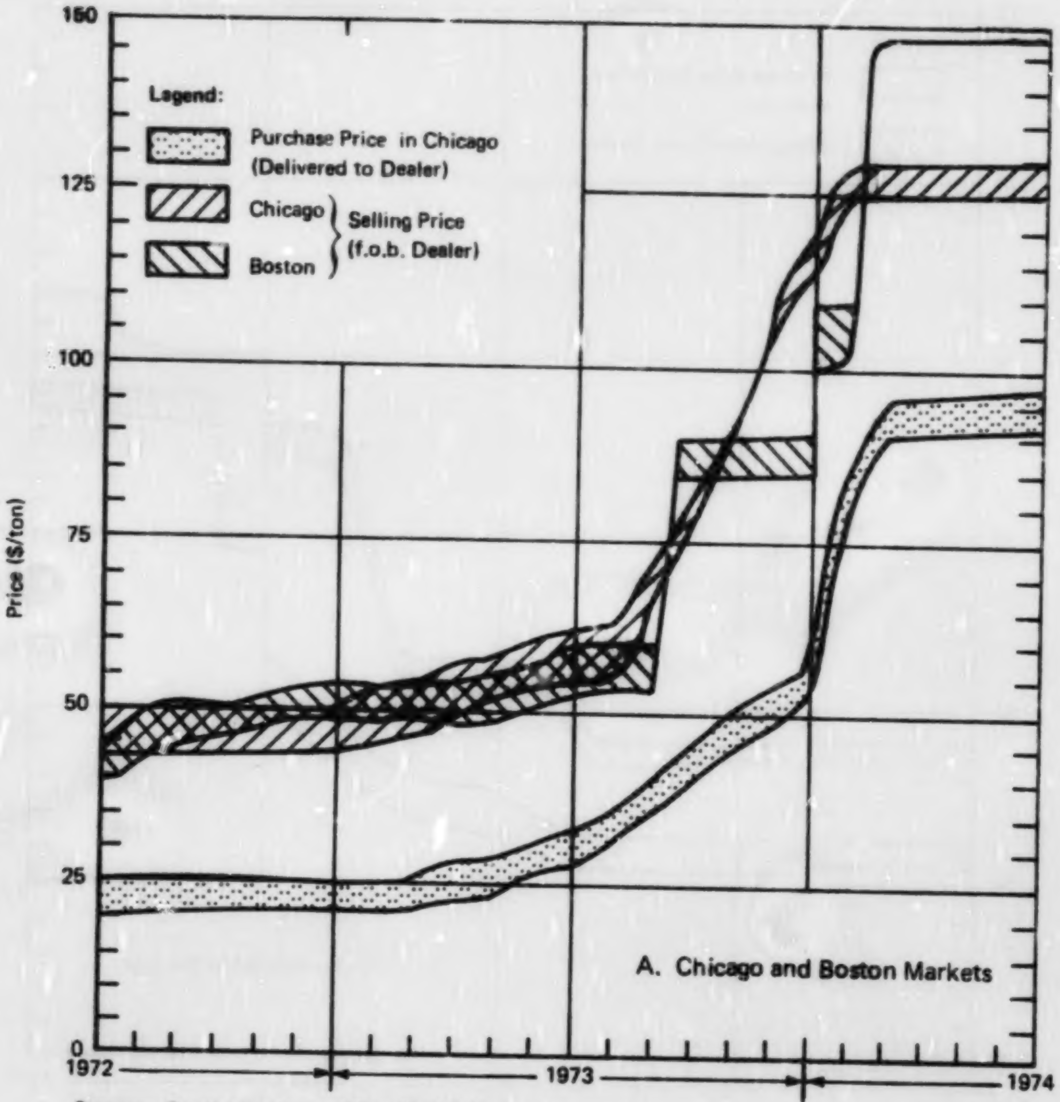
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–3 (Cont'd) DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – NO. 1 NEWS



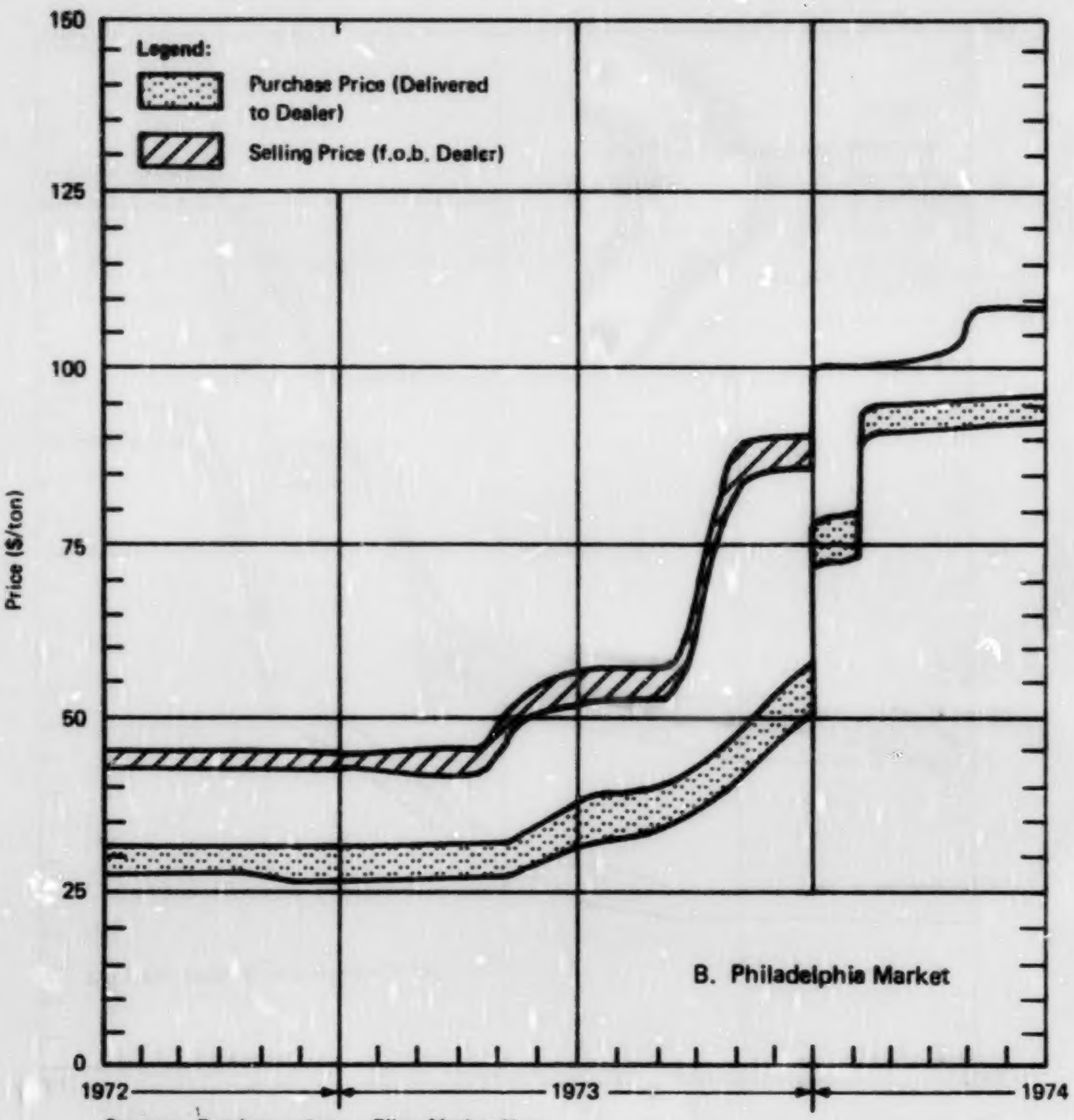
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–4 DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – WHITE NEWSBLANKS



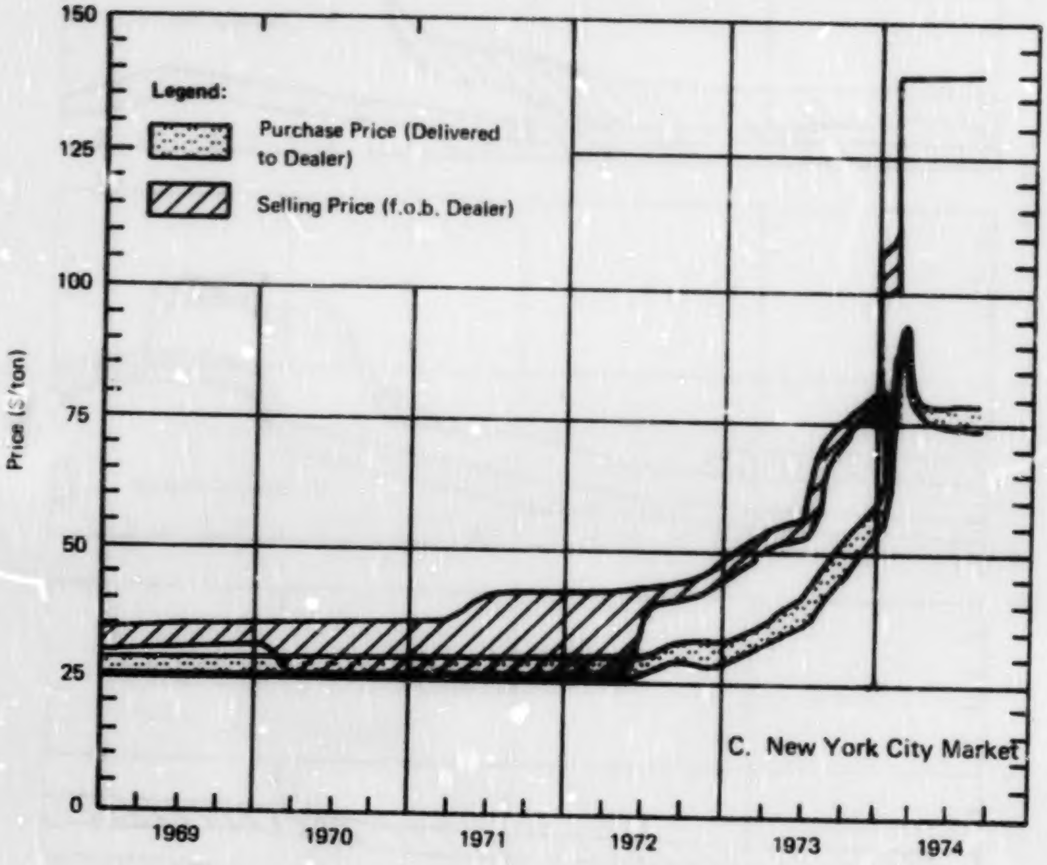
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–5 DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – WHITE LEDGER



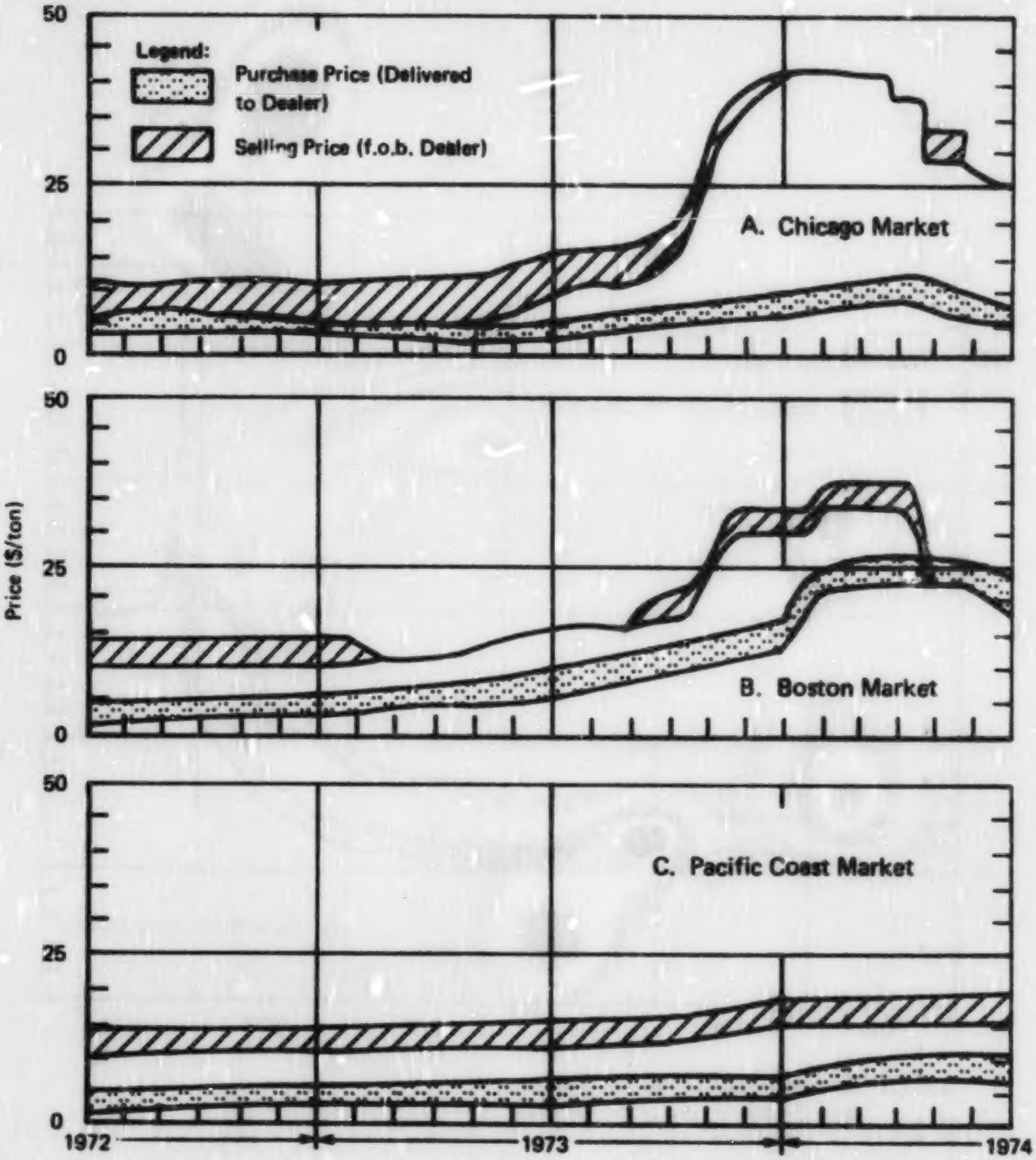
Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–5 (Cont'd) DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – WHITE LEDGER



Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–5 (Cont'd) DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – WHITE LEDGER



Sources: Purchase prices – *Fiber Market News*
Selling prices – *Official Board Market*

FIGURE VI–6 DEALER'S PURCHASE AND SELLING PRICE RANGES FOR WASTE PAPER – NO. 1 MIXED PAPER

bale, and store. Hence the higher operating margin does not necessarily mean that these products are more proficable.

In a further departure from their earlier stability, prices then declined rapidly starting about the second quarter of 1974, which was the revised base year for our cost calculations, and fell steadily through the remainder of that year. Therefore, since historical data was not a reliable guide to the future, we did not use prices that prevailed in the second quarter; instead, we derived likely long-term prices on the basis of our analysis of the various cost elements. It was these derived prices that were used in the comparative economic analysis of virgin vs. secondary fiber. Table VI-1 documents the price change that occurred between the second and fourth quarters of 1974 and lists the prices used in our economic analysis.

B. COST COMPONENTS

The economic model developed to illustrate the cost of selected grades of waste paper delivered to a mill is based upon the dealer system. The model represents the main flow of waste paper to recycling paper and paperboard mills. Obviously, there can be numerous variations of this model, depending on the specific mill; nevertheless, the model provides a convenient basis for identifying the key cost components and their influence upon the total delivered cost to a mill. We believe the lower limit on prices will continue to be determined in this way; hence, possible lower costs incurred by scavengers and/or solid-waste management firms are not likely to be passed on to a recycling paper mill.

For purposes of this cost analysis we used the costs associated with the shredding and baling of OCC and old news, because (1) these two grades constitute over 50% of the total waste paper recovered, (2) they provide convenient examples, and (3) the opportunity for substantial increases in waste paper usage rests with these two major categories.

1. Primary Pickup

Primary pickup is the price paid by the dealer to the prime collectors of waste paper, i.e., the Boy Scouts, civic, social, or religious organizations, or a private commercial/industrial source. Where applicable, i.e., news, it includes the cost for door-to-door pickup and delivery of bundled news to a concentration point such as a school yard. In other instances, e.g., OCC, P/S, and Mixed, it includes the cost of collection in a commercial and/or industrial building and delivery to the "shipping dock." In still other instances, it includes the cost of door-to-door pickup and delivery of the bundled waste paper directly to the dealer's "receiving yard." This is the item shown on the figures previously presented as the Dealer's Price. Clearly, it is ill-defined, since in some instances it includes transportation to the dealer's receiving area and in others it does not.

TABLE VI-1

COMPARISON OF THE SELLING PRICES OF SELECTED COMMON PAPER STOCK GRADES WITH THOSE USED IN COST MODELS

Basis: Baled waste ($/ton, f.o.b. dealer)

Market City or Area	Corrugated Containers			No. 1 News			P/S and High Grade De-Inking (Ledger)			No. 1 Mixed		
	2nd Qtr 1974	Dec. 1974	Used in Cost Models	2nd Qtr 1974	Dec. 1974	Used in Cost Models	2nd Qtr 1974	Dec. 1974	Used in Cost Models	2nd Qtr 1974	Dec. 1974	Used in Cost Models
NORTHEAST			36			32			125			16
Buffalo	50	20	-	30	15	-	115	110	-	26	10	-
Boston	40	10	-	35	10	-	150	95	-	25	5	-
New York	40	10	-	40	10	-	140	95	-	25	5	-
Philadelphia	40	10	-	40	15	-	110	85	-	25	5	-
NORTH CENTRAL			41			27			109			20
Chicago	45	25	-	45	25	-	130	110	-	35	10	-
Cincinnati	45	25	-	40	20	-	130	100	-	30	12	-
Cleveland	45	25	-	35	18	-	110	95	-	35	13	-
Detroit	45	25	-	45	20	-	120	115	-	30	9	-
SOUTH	45	25	40	40	20	27	100	100	100	30	10	15
Southeast Area	45	25	-	40	20	-	70	120	-	30	10	-
PACIFIC			41			27			100			20
Los Angeles Area	46	25	-	37	20	-	115	90	-	17	8	-
San Francisco Area	47	26	-	38	22	-	115	100	-	17	11	-

Source: Official Board Markets for reported prices: Arthur D. Little, Inc., estimates for prices used in economic analyses

While this item is a "price", it nevertheless represents the cost incurred by the dealer to stimulate the primary collection system. It is by far the most volatile of the cost components, since it is influenced by the supply/demand balance and has little relationship to the actual costs incurred in providing this function of primary collection. Obviously, at the historical low "price"--$2 to $10 per ton for the bulk grades (OCC, news and mixed)--the cost for primary pickup is higher than the price; hence the primary collection system was based upon volunteer labor, e.g., the Boy Scouts, and the sale of byproducts, e.g., by the solid-waste collectors.

2. Box Pickup, Hauling, and Demurrage Charges

Part of the services provided by a dealer organization is to supply a collection box to the primary collector. Typically, a religious or civic organization will ask a dealer to provide a collection box for depositing bundles of waste news when organizing a waste paper drive. These generally hold 30-60 cubic yards, or about 10 to 20 tons respectively of waste news. The costs incurred by the dealer therefore include:

- the delivery of the container to the collection point;
- the demurrage charge for the container, and
- the pickup and delivery of the container to a baling press or directly to a recycling mill.

Table VI-2 lists typical costs for the above.

The primary pickup system for the other grades is quite dissimilar. For example, with mixed paper, the solid-waste collector is paid by the commercial or industrial firm that generates it to haul it away. The collector may then be able to sell this solid waste material to a dealer. The income that he receives ($2-$5 per ton) constitutes the supplementary income; it seldom is sufficient to cover the actual cost of primary trash collection.

The cost for primary pickup of OCC is dissimilar from either of the two previously discussed grades. In this instance, the "price" paid by the dealer is for loosely baled or compacted OCC delivered to the dealer's yard by the prime generator. Uncompacted OCC is seldom transported; the low density of corrugated boxes makes it prohibitively expensive to employ the "box" pickup system used for newspaper or the packer truck system used in the primary pickup of mixed waste paper. Frequently, the dealer will help finance the installation of a small baling system (500-1000 lb bale) at the primary generator's plant and defray his cost by paying somewhat less per ton. Other arrangements are also used in bundling and financing the primary baling system.

P/S and high-grade deinking grades are recovered primarily from printing and converting sources. As with OCC, the dealer will frequently help to

TABLE VI-2

ESTIMATED COST OF BOX PICKUP AND HAULING

A. Box Size = 30 cu yd

Assumptions:
- Box holds 10 tons news
- Box cost = $1,500
- Box life = 3 years ($500/yr)
- Tractor cost w/driver = $18/hr

CONDITION 1
- Fill-up time --- 2 wks (i.e., 25 loads/yr)
- Full load each trip = 10 tons

Item	$/box	$/ton
Demurrage ($500/25)	20	2.0
Pickup (1/2 hr each way)	18	1.8
	38	3.8

CONDITION 2
- Fill-up time --- 3 wks (17 loads/yr)
- 7-ton load each trip

Item	$/box	$/ton
Demurrage ($500/17)	30	4.2
Pickup (1/2 hr each way)	18	2.6
	48	6.8

(Continued)

TABLE VI-2 (Cont'd)

B. Box Size = 60 cu yd

Assumptions:
- Box holds 20 tons news
- Box cost = $2,500
- Box life = 3 years($840/yr)
- Tractor cost w/driver = $22/hr*

CONDITION 1
- Fill-up time --- 2 weeks (i.e., 25 loads/yr)
- Full load each trip = 20 tons

Item	$/box	$/ton
Demurrage ($840/25)	34	1.7
Pickup (1/2 hr each way)	22	1.1
	56	2.8

CONDITION 2
- Fill-up time --- 3 wks (17 loads/yr)
- 15 tons/trip (75% full)

Item	$/box	$/ton
Demurrage ($840/17)	50	3.3
Pickup (1/2 hr each way)	22	1.5
	72	4.8

---

* Rate is higher than for 10-ton box, because larger tractor is required for the 20-ton load.

Source: Arthur D. Little, Inc., estimates.

install a primary baling or bundling system at the source; uncompacted P/S and deinking grades are seldom transported.

3. Sorting and Baling

The degree of sorting depends on the paper stock grade, and the degree of automation (hence, the capital investment and operating cost for this process step) varies widely. Obviously, a highly automated system would have proportionately lower direct labor and higher capital-related cost than one not as highly automated. Similarly, the higher-added-value P/S and high-grade deinking grades can absorb higher sorting costs in their selling prices than can OCC and mixed bulk grades.

Our model for sorting and baling costs (see Tables VI-3 through VI-6) is based on the typical size of a new facility producing shredded, baled news and OCC. New facilities for handling the higher-added-value pulp substitute grades tend to be smaller than this, and many existing facilities that handle either the commodity or pulp-substitute grades are smaller still. (As shown in Table V-8, dealer sales ranged from about 3000 tons to 11,000 tons in 1970, depending on the region; we have no information on the specific grades involved in these averages, but we believe that the variations in tonnage partly reflect differences in the grades of waste processed.)

Table VI-7 summarizes the costs of news and OCC, f.o.b. dealer's shipping point. Clearly, the single most important item is that for primary pickup, or the cost paid by the dealer to stimulate the supply.

A dealer's profit margin was added in these cost models to arrive at the f.o.b. prices previously shown for these grades in Table VI-1. The same rationale was used in arriving at the estimated prices for P/S, high-grade deinking, and mixed listed in that table.

With this model, we can simulate the cost for any region by using the reported "dealer's purchase price" and various sets of assumptions regarding the fraction of waste paper collected by the dealer vs. that delivered to his plant "over the scale."

4. Transportation from Dealer to Mill

a. Approach

Consistent with the previous section, in which the economic model of waste paper collection, sorting, and baling was based upon the dealer system, we have also based the transportation cost for waste paper delivered to a recycling paper/paperboard mill on the dealer system. Again, numerous other alternatives and material flow channels exist by which waste paper can be delivered to a mill--e.g., public and/or social organizations can deliver collected waste paper directly to a mill, or large dealers can operate their own delivery system and sell waste paper on a delivered basis.

(continued on page VI-23)

TABLE VI-3

ESTIMATED PLANT INVESTMENT FOR WASTE PAPER SORTING AND BALING

BASIS: Production - OCC: 100 tpd; 2,200 tpm; 26,000 tpy
News: 100 tpd; 2,200 tpm; 26,000 tpy

Operation - 12 hr/day (avg), 22 dpm

Product - Shredded OCC
- Shredded News

Item	Installed Equipment Cost ($000)
Balers (2 horizontal) incl: baler feed, take-away conveyor, and control center	240
Hoggers w/motors (2)	60
Front End Loader	20
Fork Lift Trucks (2)	27
Building (includes Process, Warehouse, Office and Maintenance Shop)	82
Yard (fence, parking lot, scale, guard house, dumping pad)	40
Spare Parts	12
TOTAL DIRECT PLANT COST	481
Engineering, Construction Supervision and Fee	58
TOTAL PLANT INVESTMENT	539

(Excl. working capital & land)

Use $540,000

Source: Arthur D. Little, Inc., estimates based on interviews with Consolidated Fibres, Inc.

TABLE VI-4

SUMMARY OF ESTIMATED OPERATING COSTS FOR WASTE PAPER SORTING AND BALING

BASIS: Production 100 tpd each OCC and No. 1 News; Total annual production 52,000 tons

Plant Investment: $540,000

Item	Units	Units/ ton	Cost $/ton	Cost $000/yr
Dealer's Purchase Price			Not Included	
Direct Labor w/Fringe Benefits	Man-hr	0.5	2.1	112
Supplies (Maintenance & Operating)		-	1.0	52
Power	kWh	5	0.1	6
Plant Supervision & Overhead		-	1.9	100
Depreciation @ 10% of Plant Investment		-	1.1	54
Taxes & Insurance @ 2-1/4% of Plant Investment		-	0.2	12
	TOTAL		6.3	336

Source: Arthur D. Little, Inc., estimated based upon interviews with Consolidated Fibres, Inc.

TABLE VI-5

ESTIMATED DIRECT LABOR REQUIREMENTS

Shift Position	Number of Men
Yard	1
Front End Loader Operator	1
Baler Operator	2
Fork Lift Truck Operator	2
Sorters	2
Utility	1
Maintenance	1
Foreman	1
Total	11

Labor Cost: $10,200/man-year (incl. fringe) X 11 = $112,000/yr

TABLE VI-6

ESTIMATED PLANT OVERHEAD

Item	Annual Cost
Manager	$35,000
Area Brokers (2 @ $20,000/man-yr)	40,000
Office Help (1 @ $8000)	8,000
Total Salaries (w/fringe benefits)	83,000
Office & Travel Exp. @ 20% Salaries	16,000
Other Services - Accounting, Legal	1,000
Total	$100,000

Source: (both tables) Arthur D. Little, Inc., estimated based upon interviews with Consolidated Fibres, Inc.

TABLE VI-7

SUMMARY OF ESTIMATED DEALER'S COST FOR BALED, SHREDDED NEWS AND OCC

Basis: 100 tpd each baled shredded news and OCC
Plant Investment: $540,000
Operation: 12 hr/day, 22 dpm
North Central location

	Cost ($/ton)	
	News	OCC
Primary Pickup[a]	14	25
Box Pickup, Demurrage & Hauling	4[b]	c
Shredding & Baling	6	6
Total	24	31

[a] Price paid by the dealer to stimulate supply

[b] Assume 40% of the news would be delivered to the dealer; only 60% would come via box pickup

[c] Not applicable. Assume all OCC is delivered to dealer in prime generator's vehicles.

Source: Arthur D. Little, Inc., estimates based upon information obtained in interviews with Consolidated Fibres, Inc.

Within the dealer system we have selected for cost estimating, waste paper is priced f.o.b. dealer. Waste paper prices by grade and region are published (Section A), but transportation to the mill is an additional and highly variable cost. To estimate representative freight costs, we have developed data for three methods of transporting waste paper from dealer to mill: common carrier, rail, and a mill-owned truck fleet.

b. Common Carrier

Approximately 75% of the waste paper used by the paper and board industry is transported by trucks. Most of these are privately owned by waste paper dealers or paper and board producers. In the latter case, the higher-value mill products are delivered, and the trucks return with waste fiber. (See Subsection d. below.)

Common motor carriers of general commodities have little incentive to participate in waste paper traffic, because rail and contract carriers charge lower rates. However, established common carrier rates are readily obtained, provide a convenient data base, and indicate the rates with which other methods of transportation compete. Figure VI-7 shows the common carrier rates for paper stock in New England. The minimum loads of 12 and 16 tons are representative of waste paper transportation.

In the Moshman* study of transportation rates, comparable moves by common and contract carriers showed that the contract rates were about 75% of the common. These rates are set by individual contract terms and are not published. There are variations from company to company rather than regional differences. For this reason, we have used the New England common carrier rates as a representative data base for all regions.

Common carrier rates reported are for 1974 second quarter. Since then, additional increases of 8%, 2.2%, and 1% have been allowed through the end of 1974. These rate increases are typical of all regions.

c. Rail

The transportation of waste paper by rail is typically over longer distances than by truck, and loads average about 40 tons per car. The rate applies to paper, waste, or scrap; there is no grade distinction. These transportation rates are reported in the TD-1 carload waybill statistics. The waybill sample is taken from audited revenue waybills for carloads terminated by line-haul operating railroads with an average revenue of $3 million or more and filed with the ICC. A 1% proportional sample is reported in the statistical tables. The Moshman study used the 1969 carload waybill statistics, which include Ex Parte 259B, November 28, 1969. The Ex Parte rates granted since then can be used to increase them

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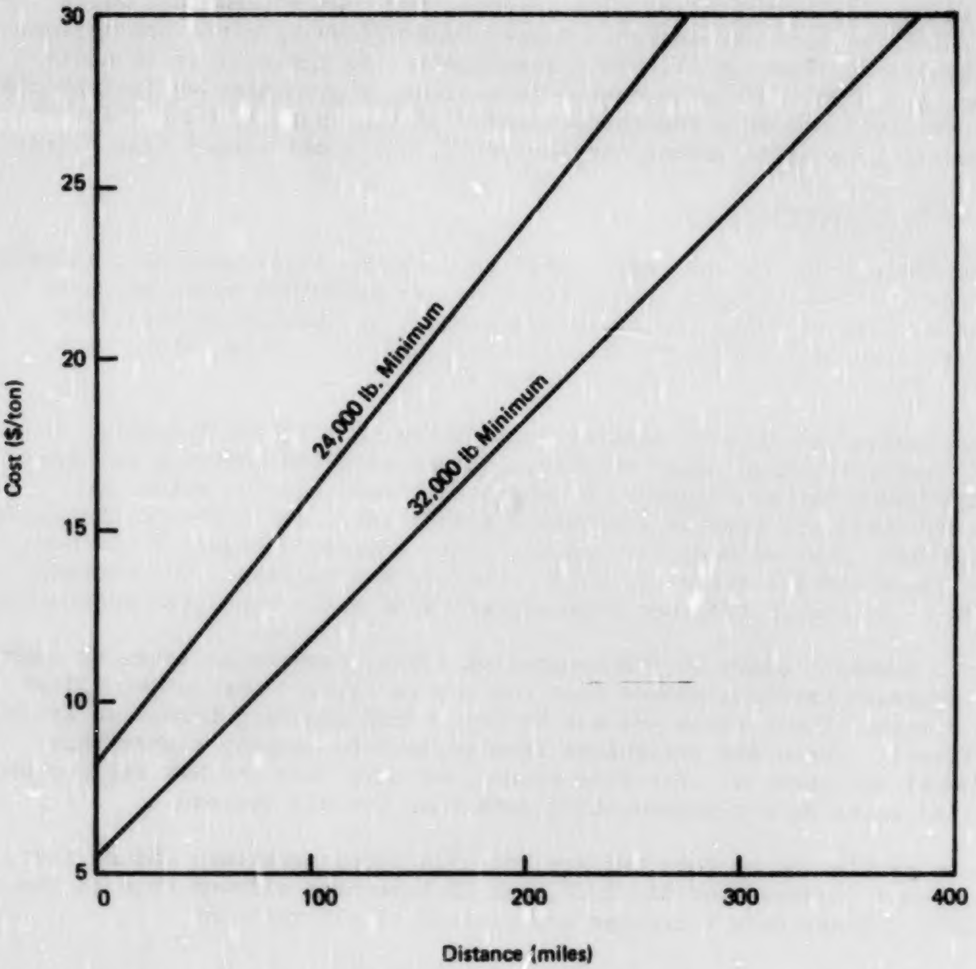
* Moshman Associates, Inc., "Analysis of Transportation Rates and Costs for Selected Virgin and Secondary Commodities," report to Environmental Protection Agency, 1973.



Basis: Class V Commodity Products, 1974 Second Quarter Rates

Source: New England Motor Rates Bureau

FIGURE VI–7 COST OF TRANSPORTING PAPER STOCK BY TRUCK IN THE NEW ENGLAND REGION (Common Carrier Rates)

so as to apply to some later time. Although we have the 1972 waybill, we have chosen to use the Moshman data because they identify the origin and destination by town and state and thereby enable us to assign rates to the census regions used in this report.

Rate increases granted by the ICC for all commodities (including waste paper) after Ex Parte 259 are as follows:

Ex Parte 262	1969	6%
265	1970	6%
267	1971	11%
281	1972	3.1%
295	1973	3%
299	1974	2.8%
303	1974	4%
305	1974	3.3% surcharge
305	1974	10.2% general freight
310	1975	7%

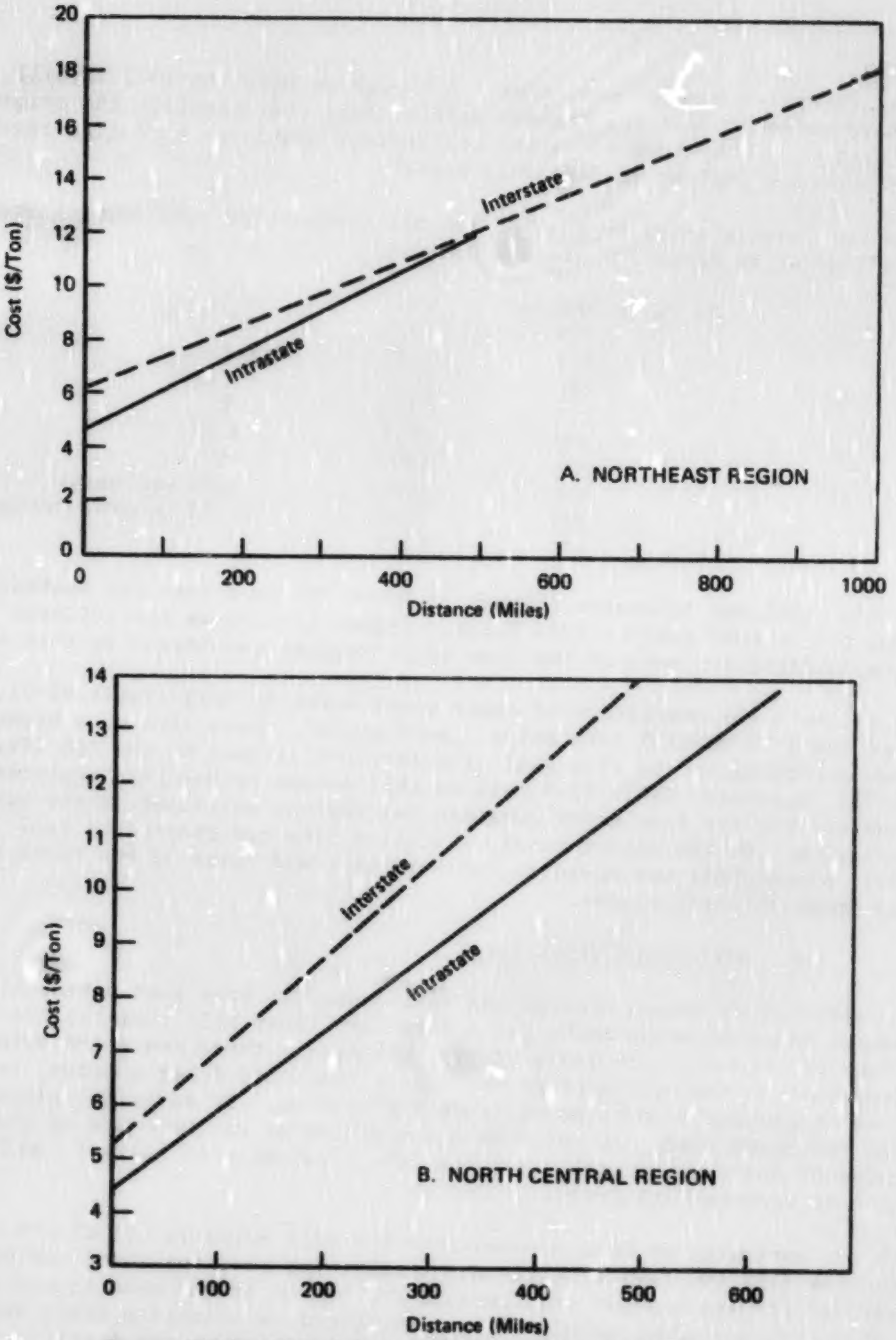
We have included increases through Ex Parte 303 to adjust the Moshman data to a second quarter 1974 basis. Figure VI-8 shows the adjusted data, plotted for each of the four major regions considered in this study.

To estimate the quantities of waste paper moved by rail (Table VI-8), we used the 1972 waybill statistics. As supplied, these data were broken down according to the five rail rate territories used by the ICC (Figure VI-9); therefore, Table VI-8 follows this scheme rather than reporting tonnages for the four major geographical regions mentioned in the previous paragraph. Of the approximately 4 million tons transported by rail in 1972, almost half was moved in the Northeast and parts of the North Central and South Atlantic states.

d. Mill-owned Truck Fleet

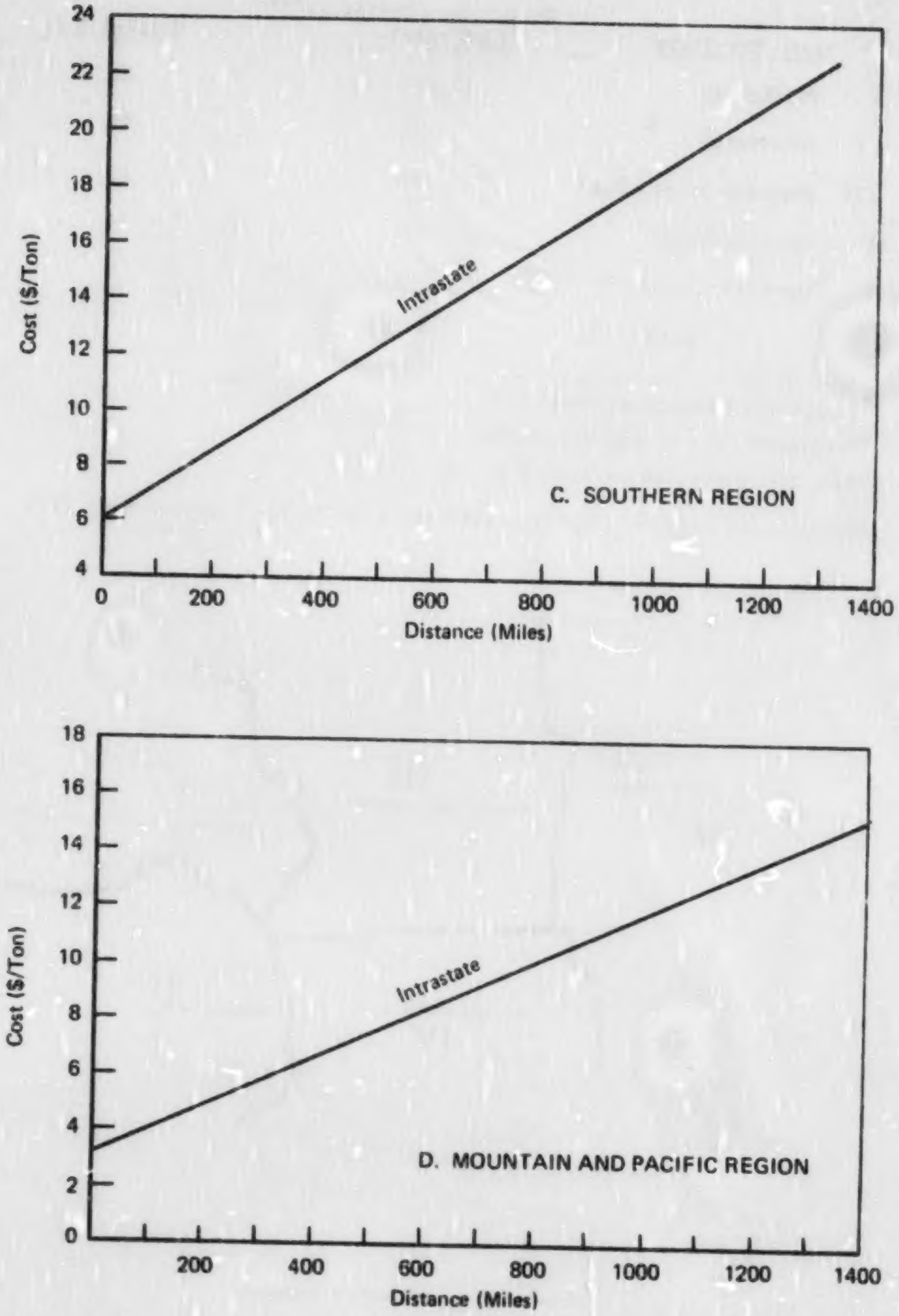
In addition to common carrier and rail costs, we have also estimated the annual transportation costs for a secondary fiber mill that has its own fleet of trucks. (See Table VI-9.) Obviously, these costs are primarily dependent on the mill's proximity to customers and fiber sources, rather than on geographic or product grade differences. In addition, since the estimated costs are based on a consolidation of the costs of product shipment and raw material receiving, the allocation of costs to each item is somewhat arbitrary.

In our estimate, we have assumed that the mill delivers all of its production (112,000 tpy) with its own trucks, and that one third (46,000 tpy) of its waste paper requirements are hauled by the same trucks on return trips. Thus, no significant equipment or operating costs are incurred by hauling waste paper. The primary purpose and justification for the truck fleet is product delivery; the back-hauling of raw materials represents a marginal benefit through more efficient operation of the fleet. On this basis, we have charged the annual operating costs of the truck fleet entirely to product delivery.



Source: ICC Waybill Statistics – 1969, TD–1, adjusted to 1974 2nd qtr.

FIGURE VI–8 COST OF TRANSPORTING WASTE PAPER BY RAIL



Source: ICC Waybill Statistics – 1969, TD–1, adjusted to 1974 2nd qtr.

FIGURE VI–8 (Continued) COST OF TRANSPORTING WASTE PAPER BY RAIL

TABLE VI-8

U.S. RAIL TRANSPORTATION OF WASTE PAPER - 1972

Rate Territory		Weight into Territory[a,b] (000 tons)	% Total U.S.
I	(Official)	1,883	48
II	(Southern)	860	22
III	(Western Trunk Line)	598	15
IV	(Southwestern)	380	10
V	(Mountain Pacific)	173	4
	Total U.S.	3,895[c]	

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[a] Incl. inter-region shipment

[b] Estimated from 1% waybill sample

[c] Does not total due to rounding

Source: ICC Carload Waybill Statistics - 1972, TD-1, Issued May, 1974

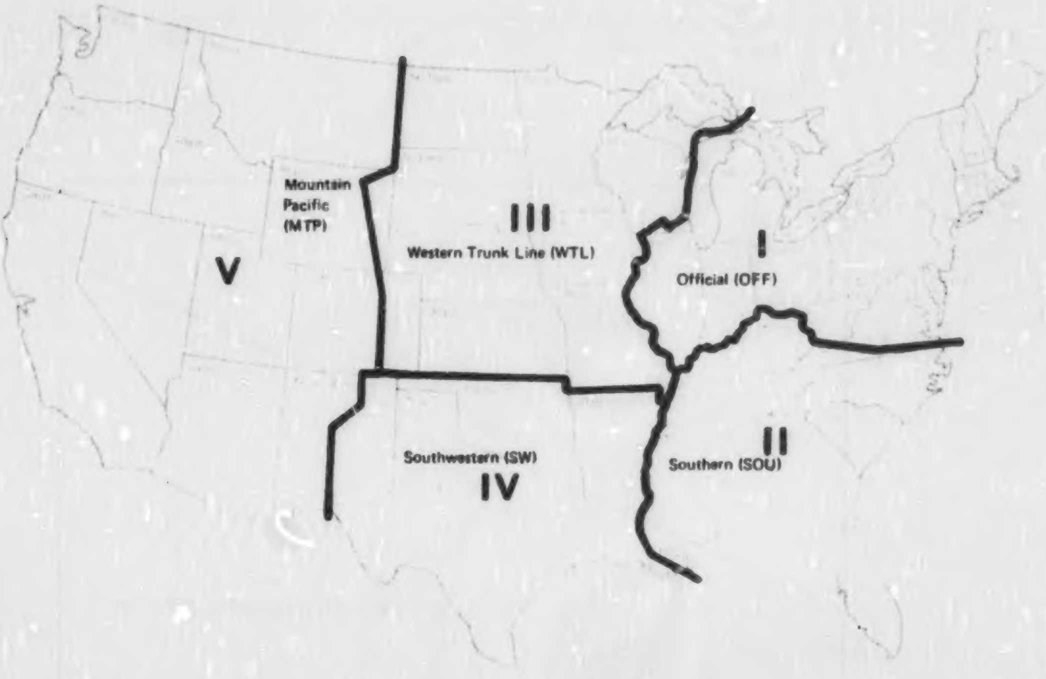
Mountain Pacific (MTP)
V
III
Western Trunk Line (WTL)
I
Official (OFF)
Southwestern (SW)
IV
II
Southern (SOU)

FIGURE VI-9 U.S. RAIL RATE TERRITORIES

TABLE VI-9

ESTIMATED TRANSPORTATION COSTS FOR SECONDARY FIBER MILL USING OWN TRUCKS

Raw Material (RM) Delivery: 412 tons/day; 140,000 tons/year
2/3 local collection (delivered to mill)
1/3 back-haul by own trucks

Customers: 6, average round trip distance 40 miles

All production (330 tons/day; 112,000 tons/year) delivered by truck*

All RM arrives by truck

Capacity per load: 16 tons

Number of trips: 28 per day, 5 days per week

Equipment: 8 trucks

Manning: 7 drivers per shift, 2 shifts per day + dispatcher + maintenance man + helper = 17.

Investment: $280,000 for trucks and supporting facilities

Annual Operating Costs	
Drivers, including fringes @ $17,500	$245,000
Operating costs: gas, oil, normal maintenance @ 28¢/mile (340,000 mi/yr)	96,000
Truck Dispatcher	15,000
Maintenance man and helper	29,000
Depreciation, taxes and ins. @ 33% of investment	93,000
Own truck costs for 112,000 tons product, 46,000 tons raw material	478,000
Remaining RM delivery costs for 94,000 tons @ $9.00	850,000
Total freight cost, in and out, for 112,000 tons of product, 140,000 tons of raw material	1,328,000
Use	$1,350,000
Allocation of Costs	
Product shipped, 112,000 tons @ $4.50	504,000
RM received, 140,000 tons @ $6.00	840,000
TOTAL	$1,344,000

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*For basis of material balance, see Section IX, Figure IX-F-4.

Accounting procedures might normally charge a portion of the trucking costs to the waste paper back-hauled, effectively crediting part of the benefits of efficient operation to product delivery. However, since it is the opportunity for back-hauling raw materials which creates the benefit, the point is best illustrated by taking credit there--i.e., not allocating costs to the waste received in the mill's own trucks.

With the above stipulations, the cost per ton of product delivered is $4.50. The cost of waste paper received is estimated at $9.00/ton on two thirds (94,000 tpy) of total requirements received by common carrier and no charge on the remaining third (46,000 tpy) that is back-hauled in the mill's trucks, giving an overall average cost of $6.00/ton freight on total annual requirements of 140,000 tons of waste paper.

Our intent in including this estimate of freight costs in and out for a mill using its own trucks is to illustrate the savings in freight which might be realized by judicious site selection. However, it is only an example; the actual cost of such an operation would depend on the average distances to customers and fiber sources, as well as actual tonnages handled.

5. Summary of Delivered Cost of Waste Paper

The aim of this analysis was to derive possible long-term prices, since historical price data did not provide a reliable base for projecting future prices. Table VI-10 summarizes our analysis of possible long-term prices—i.e., cost to a consuming mill--for the major waste paper stocks by region and grade, f.o.b. dealer (from Table VI-1), transportation costs by various methods, our estimates of transportation cost within the range for each region and grade, and thus our estimate of delivered cost. Note that in transferring the dealer's cost from Table VI-7, we have added a margin of profit to arrive at the price f.o.b. dealer.

All these costs are based on short tons; however, since our economic estimates are made on a metric ton basis, we have indicated the equivalent cost per metric ton in brackets for correlation with other sections of this report.

The common carrier rates provide a basis for estimating truck freight costs, as the latter are roughly 75% of the common carrier rates. For the Northeast, North Central, and Pacific regions, the common carrier costs are for a range of 100 - 150 miles; for the South we have assumed a more diverse geographical pattern and have used a 200-300 mile range as typical

Common carrier rates for OCC, No. 1 news, and No. 1 mixed waste paper are based on 16-ton minimum loads. We have selected sorted white ledger as an example of pulp substitute deinking grades, and for this grade we have used 12-ton minimum load rates to reflect the lower availability and consumption of these higher grades of waste paper.

Rail rates shown are based on 40-ton loads for all grades. We have selected typical distances (and used the corresponding rates) from the Moshman data plotted in Figure VI-8 as follows:

Northeast	500 miles
North Central	300 miles
South	700 miles
Pacific	1000 miles

As the lower end of the range for freight costs, we have included mill-owned trucks at $6.00 per ton for all regions and grades. This value is representative of the conditions we have assumed for our cost estimate, which would be independent of region or paper grade. However, it is not a fixed number; it would vary with specific conditions, and is included only as an example.

We have estimated freight costs within the overall range for each grade and region, based on our judgment of all factors involved. In general, we have used the lower-range costs for OCC, No. 1 news, and mixed waste paper and higher costs for pulp substitute deinking grades because of their higher value and smaller total shipments. We have estimated higher costs in the South for all grades to indicate a more dispersed industry with longer average shipping distances.

C. RECOVERY OF PAPER STOCK FROM MUNICIPAL SOLID WASTE

In addition to the potential supply of waste paper segregated at points of origin in both the consumer and commercial/industrial sectors, increased interest has recently focused on municipal solid waste (MSW).* Midwest Research Institute (MRI), in a recent study of this field,** predicted that by 1985 about 2-3 million tons, or about 10% of the estimated quantity of waste paper required by the industry, will be obtained from MSW. Of this, according to MRI, some 500,000 tons will be recovered via mechanical separation and the balance via conventional channels, such as curbside pickup of old news and "hand-picking" of OCC from the feed conveyor in a solid-waste disposal plant.

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* Forest Products Laboratory, "Recovery and Reuse of Waste Paper from Shredded Household Trash," J.R. Laundrie, U.S. Forest Service Research Paper FPL-252 (1975); A.A. Mohaupt and J.W. Koning, Jr., TAPPI, Vol. 57, No. 11 (November 1974), p. 56.

**W. E. Franklin, "Base Line Study of Resource Recovery from Municipal Solid Waste, 1972-1990," report to EPA by Midwest Research Institute (in press). See also D. Bendersky, R. J. Reid, and W. E. Franklin, "A Technical and Economic Evaluation of Waste Paper Recovery Systems," report to Boxboard Research and Development Association by Midwest Research Institute, December 13, 1974.

TABLE VI-10

SUMMARY: DERIVATION OF DELIVERED COST OF WASTE PAPER USED IN COST MODELS

	OCC			NO. 1 NEWS			PULP SUBSTITUTE (SORTED WH.LEDGER)			NO. 1 MIXED		
NORTHEAST												
Price per short ton [$/metric ton] (f.o.b. dealer)		36	[40]		32	[35]		125	[137]		16	[17]
Common Carrier, $/short ton(1) 100-150 miles	13			13			20			13		
Rail Freight, $/short ton(2) 500 miles	12			12			12			12		
Own trucks, $/short ton(3)	6			6			6			6		
Freight for cost model: $/short ton [$/metric ton]		9	[10]		9	[10]		18	[20]		7	[8]
Delivered cost: $/short ton [$/metric ton]		45	[50]		41	[45]		143	[157]		23	[25]
NORTH CENTRAL												
Price per short ton [$/metric ton] (f.o.b. dealer)		41	[45]		27	[30]		109	[120]		20	[22]
Common Carrier, $/short ton(1) 100-150 miles	13			13			20			13		
Rail Freight, $/short ton(2) 300 miles	9			9			9			9		
Own trucks, $/short ton(3)	6			6			6			6		
Freight for cost model: $/short ton [$/metric ton]		9	[10]		9	[10]		18	[20]		7	[8]
Delivered cost: $/short ton [$/metric ton]		50	[55]		36	[40]		127	[140]		27	[30]

TABLE VI-10 (cont'd)

	OCC			NO. 1 NEWS			PULP SUBSTITUTE (SORTED WH.LEDGER)			NO. 1 MIXED		
SOUTH												
Price per short ton [$/metric ton] (f.o.b. dealer)		40	[45]		27	[30]		100	[110]		15	[17]
Common Carrier, $/short ton(1) 200-300 miles	20			20			27			20		
Rail Freight, $/short ton(2) 700 miles	15			15			15			15		
Own trucks, $/short ton(3)	6			6			6			6		
Freight for cost model: $/short ton [$/metric ton]		14	[15]		14	[15]		23	[25]		12	[13]
Delivered cost: $/short ton [$/metric ton]		54	[60]		41	[45]		123	[135]		27	[30]
PACIFIC												
Price per short ton [$/metric ton] (f.o.b. dealer)		41	[45]		27	[30]		100	[110]		20	[22]
Common Carrier, $/short ton(1) 100-150 miles	13			13			20			13		
Rail Freight, $/short ton(2) 1000 miles	12			12			12			12		
Own trucks, $/short ton(3)	6			6			6			6		
Freight for cost model: $/Short ton [$/metric ton)		9	[10]		9	[10]		18	[20]		7	[8]
Delivered cost: $/short ton [$/metric ton]		50	[55]		36	[40]		118	[130]		27	[30]

(1) Common carrier rates estimated for mileage blocks indicated. Contract carrier rates would be approximately 75% of common carrier rates.

(2) Rail rates estimated for 40-ton loads for mileage indicated.

(3) Rate for mill-owned trucks based on our cost model. Variations in the conditions assumed for this model would result in variations in the rate.

This section describes how mechanical separation is achieved and how much it might be expected to cost. Only dry techniques are considered here; wet processing, which has been used for several years, has been found to produce a fiber with limited commercial utility. Information on the latter is available from other sources.

1. Generalized Process for Reclamation

The generalized process flow sheet for a fiber recovery operation (probably coupled with recovery of other materials such as glass and metals) could be envisioned in three stages. The first stage is the segregation of a fiber-rich fraction from the remainder of the MSW stream. In dry processing techniques, the heart of the segregation process is generally air classification. This is a separation process which utilizes differences in specific surface areas (the ratio of surface area to mass) to effect separation in a horizontal or vertical column of moving air. Because paper and paper products generally have higher specific surface areas than other materials in MSW, this fraction, along with plastic films, metal foils, and very fine particles of glass and dirt (the major contaminants) is discharged from the classifier as the "floats" stream. Other metals, glass, plastics, etc., are discharged as the "sinks" stream.

Before it can be effectively classified, the refuse must be "groomed" so that it enters the classifier as discrete bits that encounter the air stream one at a time. For maximum efficiency of separation, the bits should be as uniform as possible in size and shape. The preprocessing customarily includes one or more stages of shredding by hammermills, flail mills, or similar machines; screening may also be used to remove oversized material, which might cause blockage farther downstream, and undersized material such as dirt or glass. Ferrous materials are usually removed by magnetic separation. Hand picking is often employed to remove certain categories of materials such as explosive items (fuel and solvent cans), heavy metal castings (e.g., engine blocks), tires, bundled newspapers and corrugated board, and large pieces of nonferrous metals. Drying may also be used, because controlled moisture content enhances the efficiency of air classification.

The second stage of processing in the reclamation of fiber is the upgrading or beneficiation of this fiber-rich stream by removing as much of the nonfibrous material as possible. The materials to be removed are plastics, metal foils, glass, dirt, and food wastes. Those that are not attached to the paper can be separated fairly easily, but paper that is coated with foil or adhesive, laminated to plastic, soaked with greases and other food wastes, etc., can be very troublesome.

To remove the discrete as well as the "mixed" contaminants, each of the operations described above can be reused, but with greater control, because the classification of this material is more difficult. Thermoplastic films can be removed from the stream by contacting them with a heated surface to which they will adhere, or, as is done by the Forest Products Laboratory, they can be exposed to hot gases that cause them to shrivel, thus materially decreasing their specific surface area so they can be air-classified from the paper fraction. There are also electrostatic techniques for removing plastics. Fine glass and dirt can generally be removed by repeated screening. Considerable research is being done in this area at present, since the reclaimed material from this stage of beneficiation would be adequate for many commodity-grade paper products (combination board, roofing felt, newsprint, corrugating medium, etc.).

The third stage is to produce a distinct, impurity-free pulp grade from the fiber mixture typically found in MSW. As noted earlier, the paper fraction recovered from MSW consists of about 60% chemical fiber and 40% mechanical fiber, and it contains a mixture of softwood and hardwood pulps that may be bleached, unbleached, or semibleached. As a result, the recovered "unbeneficiated" fraction has limited potential for recycle applications. The separation of the fiber mixture into its constituent components is a challenging problem, and a commercially practicable solution has not been demonstrated to date.

2. FPL Air Separation Process

The following is a discussion and preliminary economic analysis of the air separation process developed by the Forest Products Laboratory. We believe this to be the most advanced technique for beneficiating the recovered paper fraction from MSW. (Other processes at various stages of development include the ballistic separation process developed by Franklin Institute, the air separation process developed by the U.S. Bureau of Mines, and the wet process developed by Black-Clawson.)

a. Method of Operation

Figure VI-10 is a schematic diagram of the FPL process. The primary shredding of the MSW is performed in a vertical-shaft hammermill. The coarse shredded waste from the hammermill is deposited onto a belt conveyor, and the ferrous metal contaminants are removed by a magnetic separator. The primary classification is accomplished at the discharge from the belt conveyor via a vacuum pickup, which removes the light, paper-rich fraction and rejects the heavy materials.

The material separated by the vacuum pickup is transferred to a vibrating screen, which removes oversized materials** and "fines" (organic and inorganic particles such as glass, sand, and garbage carried over with the "light" fraction).

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* J.F. Laundrie, U.S. Patent 3,814,240.

**The oversized materials are removed because FPL's pilot plant, being a small-scale model, cannot handle the largest pieces of shredded, "light" material recovered in the vacuum pickup.

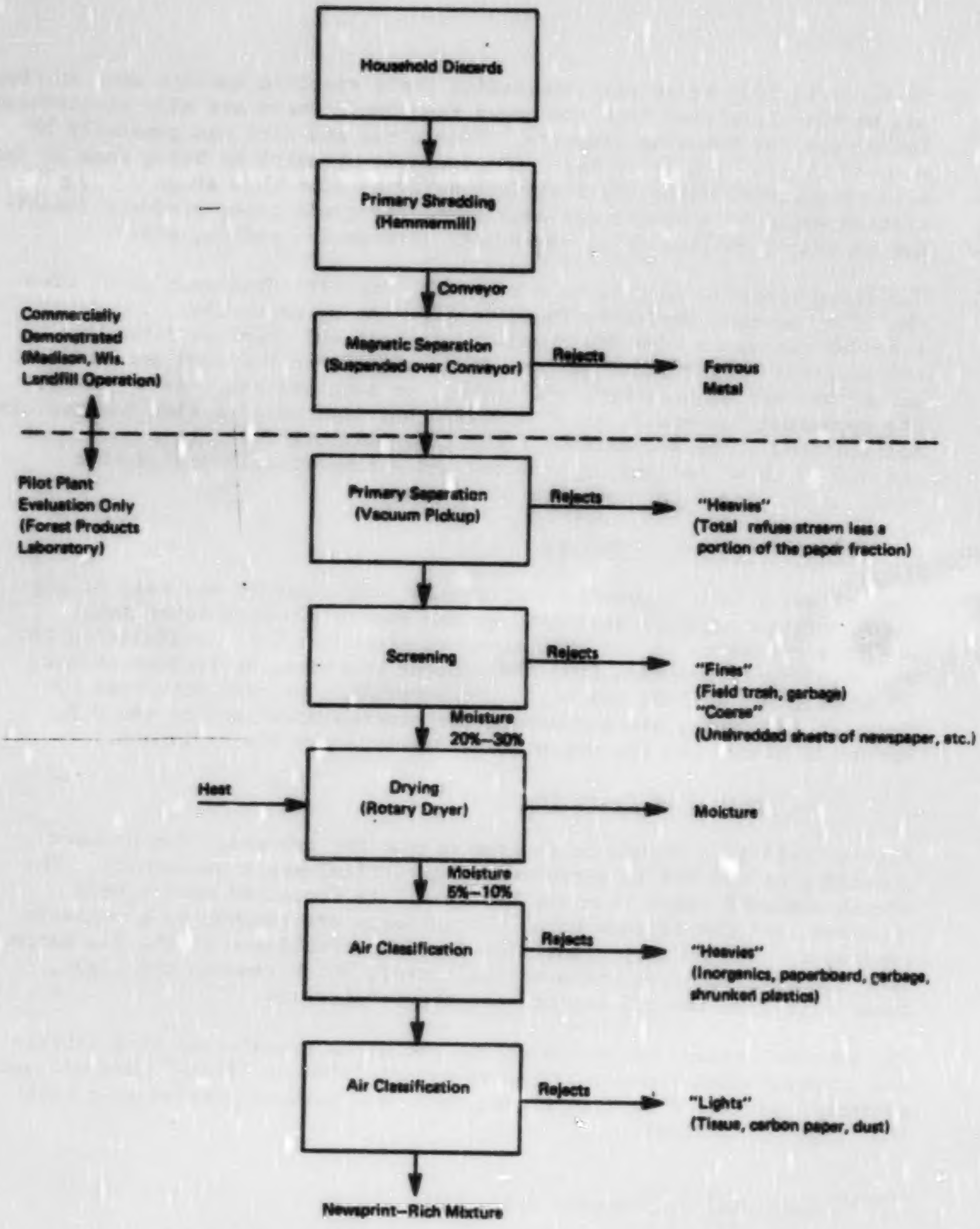
Household Discards
Primary Shredding (Hammermill)
Conveyor
Commercially Demonstrated (Madison, Wis. Landfill Operation)
Magnetic Separation (Suspended over Conveyor)
Rejects
Ferrous Metal
Pilot Plant Evaluation Only (Forest Products Laboratory)
Primary Separation (Vacuum Pickup)
Rejects
"Heavies" (Total refuse stream less a portion of the paper fraction)
Screening
Rejects
"Fines" (Field trash, garbage)
"Coarse" (Unshredded sheets of newspaper, etc.)
Moisture 20%–30%
Heat
Drying (Rotary Dryer)
Moisture
Moisture 5%–10%
Air Classification
Rejects
"Heavies" (Inorganics, paperboard, garbage, shrunken plastics)
Air Classification
Rejects
"Lights" (Tissue, carbon paper, dust)
Newsprint–Rich Mixture

FIGURE VI–10 SCHEMATIC FLOW DIAGRAM OF THE FOREST PRODUCTS LABORATORY'S WASTE PAPER SEPARATION PROCESS

The accepts from the screen are next conveyed to a rotary drum dryer, where the moisture is reduced from about 20-30% to 5-10%. The primary purpose for drying is to facilitate the subsequent air classification; the high temperature (320°F to 365°F) in the dryer contracts any plastic film present in the "light" fraction, thereby reducing its specific surface area sufficiently to permit separation from paper via air classification.

The drying operation also serves to sterilize the waste paper, which is often contaminated from contact with garbage and will decompose unless the bacteria are destroyed. The high temperature in the dryer kills the bacteria, and the low moisture content virtually eliminates future bacteriological growth. (A fluidized-bed dryer could also be used in place of the rotary drum.)

Finally, the dried waste is conveyed to two air classifiers in series. The air velocities through the classifiers are independently regulated to control the ratios of accepted versus rejected materials.

Figure VI-11 shows a material balance for the process steps that follow primary separation.

b. Economic Evaluation

As indicated earlier, only the coarse shredding and primary classification steps have been carried out on a commercial basis.* The technical feasibility of the other steps has been demonstrated, but reliable estimates of investment and operating costs must await more complete information on throughput rates and specific operating conditions. A paper fraction has been produced containing a high percentage of newsprint (estimated at 65% - 80%) that is free of both organic (plastic film and garbage) and inorganic (glass and sand) contaminants. This recovered paper has been used in experimental programs to make newsprint, corrugating medium, paperboard, and composition board. The FPL has submitted samples of the recovered fraction to several paper manufacturers (such as Garden State Paper Company, St. Regis, and Upson) for evaluation. Although the results of their tests have not yet been released, the manufacturers are reported to be optimistic.

Our analysis considers a standard-sized production module--100 tpd of newsprint-rich material. From the relationship shown in Figure VI-11, this corresponds roughly to 230 tpd of shredded trash or almost 510 tpd** of raw MWS, which is the amount produced by approximately 150,000 to 200,000 people.

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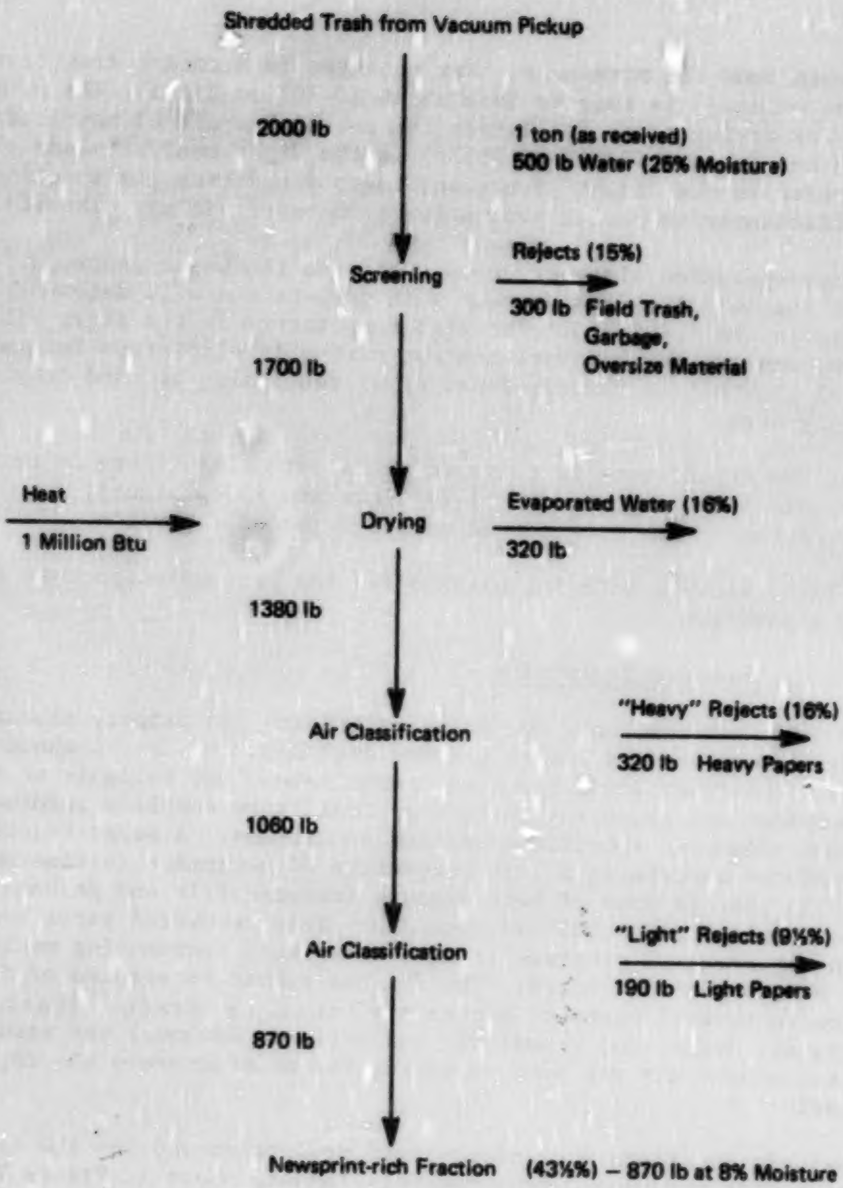
* Systems for doing this have been installed in Wilmington, Delaware, and East Bridgewater, Massachusetts.

** Based on 75% recovery of combustibles (the experience at the Madison installation), which constitute an estimated 60% of the raw MWS.


Shredded Trash from Vacuum Pickup
2000 lb
1 ton (as received)
500 lb Water (25% Moisture)
Screening
Rejects (15%)
300 lb Field Trash,
Garbage,
Oversize Material
1700 lb
Heat
1 Million Btu
Drying
Evaporated Water (16%)
320 lb
1380 lb
Air Classification
"Heavy" Rejects (16%)
320 lb Heavy Papers
1060 lb
Air Classification
"Light" Rejects (9½%)
190 lb Light Papers
870 lb
Newsprint-rich Fraction (43½%) – 870 lb at 8% Moisture

Source: Personal Communication from J. Laundrie, Chemical Engineer, FPL

FIGURE VI–11 ESTIMATED MATERIAL BALANCE FOR THE SEPARATION OF NEWSPRINT-RICH FRACTION FROM MSW

We have assumed that the investment and operating costs for primary shredding and cleaning would be the same for any disposal method, and hence have not charged them to this supplementary cleaning and classifying operation for the recovery of fiber. Improved cleaning methods could incur higher costs, and better separation may be required.

Table VI-11 shows capacity requirements for the newsprint separation process used in developing the cost calculations. The capital investment for a 100-tpd plant (8 hours per day, 5 days per week) is estimated to be $600,000 (Table VI-12). This includes process equipment as well as additional building space to accommodate the paper separation plant.

The cost of operation is estimated at $17.50 per ton of finished, newsprint-rich product (Table VI-13). This excludes the cost of the coarse shredded material used as primary feed to the separation process.

Since definitive information is not available at this time for evaluating plant investment and operating costs, we have illustrated the effect that key process variations would have on operating costs in Figure VI-12. A "best guess" operating cost ($17.60 per ton) is plotted at the origin of the graph. Possible variations of the "best guess" are plotted along the horizontal axis, and the resulting operating costs are indicated on the vertical axis. For example, product yield (newsprint) is influenced by the newsprint content of the raw waste as well as the overall efficiency of the separation process. A wide variability may be expected in this item (perhaps ± 50%). A sensitivity analysis of such a variation shows an operating cost ranging from $11.70 to $35.20 per ton. Similarly, definitive experimental data are not available for process throughput, so this variable may also fluctuate widely from our "best guess". The graph reveals, however, that a ± 50% variation in the plant investment or throughput is not as significant as one in product yield.

Obviously, more definitive information is required regarding the specific composition of the refuse raw material, and plant throughput data must be obtained to derive more precise cost calculations. Nevertheless, these preliminary cost estimates provide a basis for comparing the potential competitive position of waste paper recovered from MSW with respect to alternative raw materials.

Unfortunately, despite the technical and economic promise of the process, there are no good prospects for its commercialization at present.

D. PRICE PROJECTIONS

1. Summary and General Comments

Historical price performance provides little guidance in forecasting prices of waste paper. Cost analysis also fails to provide a precise forecasting tool, since the largest single cost component is that for primary pickup—i.e., the price paid by the dealer to stimulate a supply—which is not a tangible cost. Further, recovering selected grades from

TABLE VI-11

ESTIMATED REQUIRED CAPACITIES FOR PROCESS STEPS IN NEWSPRINT SEPARATION PROCESS

Basis: Production 100 tpd newsprint-rich material
Operation 8 hr/day @ 85% efficiency (6.8 hr)
Overall yield: 43.5%

	Capacity	
Process Step	Tons/Day	Tons/Hr @ 85% Efficiency
Screening	230	34
Drying	200	29
Air Classification (I)	160	23
Air Classification (II)	120	18
Product	100	16

TABLE VI-12

ESTIMATED TOTAL FIXED CAPITAL FOR THE SEPARATION OF NEWSPRINT-RICH MATERIAL FROM MSW

Basis:		
	Production	100 Tons/day Newsprint-rich material
	Operation	8 Hr/Day; 85% Mechanical Efficiency
	Overall Yield	43.5%*
	Year	Second Quarter 1974

Item		Cost ($000)	
Equipment			
Cyclone Collectors	(5 @ $2,000 each)	10	
Screens	(4 @ $5,000 each)	20	
Drying	(2 @ $30,000 each)	60	
Conveyors	(4 @ $5,000 each)	20	
Air Classifiers	(4 @ $10,000 each)	40	
Baling Equipment	(1 @ $70,000)	70	
Total Purchased Equipment Cost (PEC)			220
Delivery of Equipment	@ 10% PEC	22	
Mechanical Installation	@ 20% PEC	44	
Electricals	@ 15% PEC	33	
Plant Dust Collect System		30	
Vehicles: Lift Truck		14	
Front End Loader		20	
Sub-total, Equipment Installation		163	
Installed Equipment Cost (IEC)			383
Building (60 ft x 80 ft @ $10/sq ft)		48	
Heating		15	
Sprinkler System		25	
Outside Electricals		5	
Lighting		4	
Sub-total, Buildings & Lighting		97	
Total Direct Plant Cost (DPC)			480
Engineering & Construction Supervision @ 20% DPC		96	
Total Physical Plant Cost (PPC)			576
Other Fixed Capital			58
Total Fixed Capital			634
		Use	$600,000

* Newsprint-rich fraction from "light fraction"

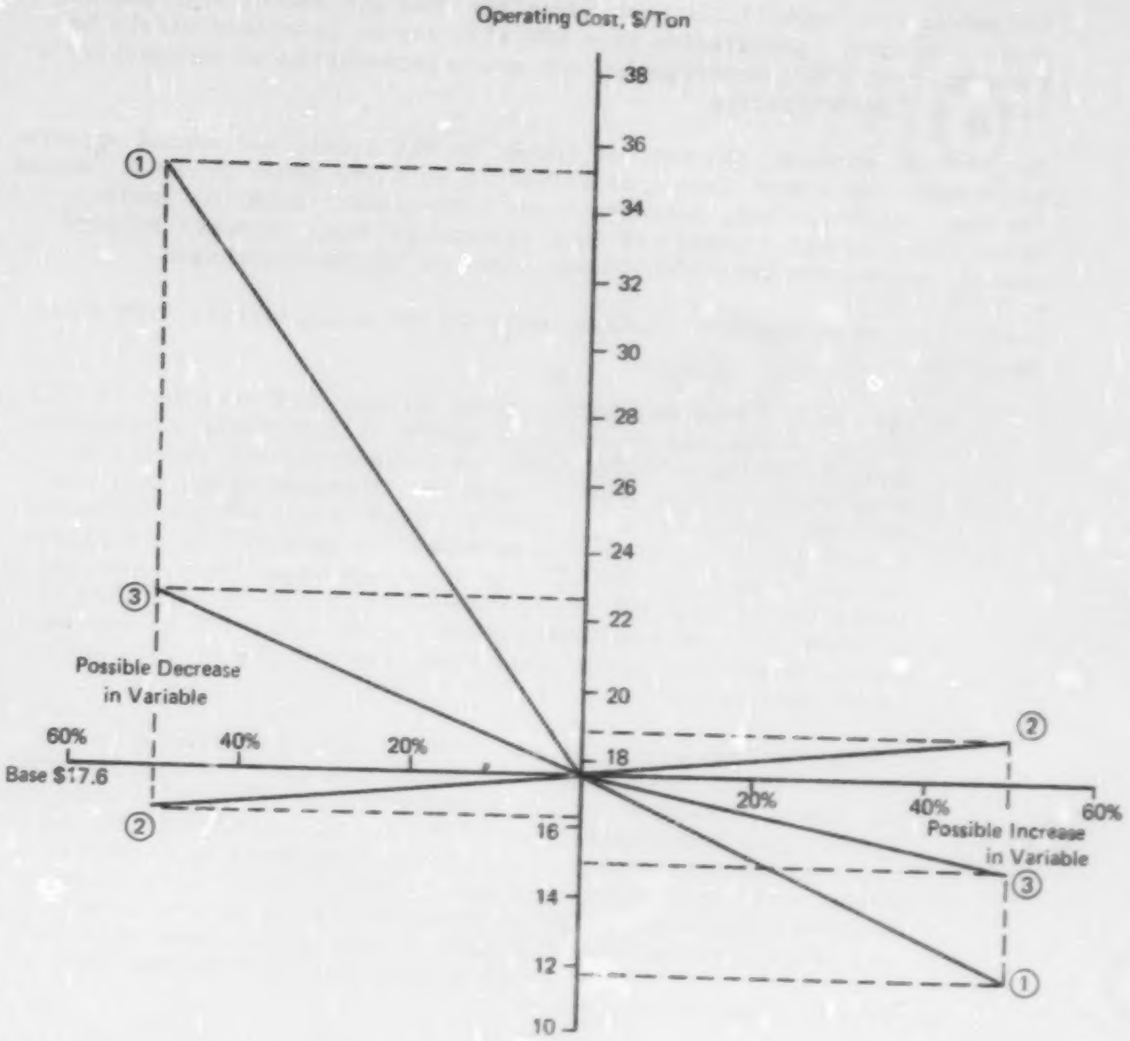
TABLE VI-13

ESTIMATED OPERATING COST FOR THE SEPARATION OF NEWSPRINT-RICH MATERIAL FROM MSW

Basis: Production : 100 tons/day; 26,000 tons/year
Product : Newsprint-rich material @ 8% moisture in bales
Overall Yield: 43.5% (newsprint-rich fraction from "light fraction")
Total Fixed Capital: $600,000

Item	Units	Units per ton	Cost ($/ton)	Cost ($000/yr)
Raw Materials:				
Coarse shredded & primary cleaned household discards			Not included	
Conversion (less capital-related):				
8 operators & 1 utility man @ $7500/man-yr	man-hr	0.8	2.6	68
Maintenance - 1 skilled & 1 helper	man-hr	0.2	0.8	20
Fringe Benefits @ 32% Direct Labor			1.1	28
Fuel	MM Btu	5.26	7.9[a]	205[a]
Power	kWh	4	0.8	20
Operating & Maintenance Supplies			1.0	26
Factory Overhead			1.0	26
TOTAL CONVERSION COST			15.1	393
Capital-Related:				
Depreciation @ 10% Total Fixed Capital			2.3	60
Insurance @ 3/4% Total Fixed Capital			0.2	5
TOTAL CAPITAL-RELATED			2.5	65
TOTAL OPERATING COST (f.o.b. Plant)			17.6	458

[a] This cost could be greatly reduced by recirculating part of the hot gases and also by using part of the MSW as fuel -- especially the shrunken plastics, which are high in fuel value.



Key Variables	Percent Variation	Best Guess	Possible High	Possible Low
① Newsprint Fraction Yield* (%)	+50, −50	43.5	65.2	21.7
② Total Fixed Capital ($000)	+50, −50	600	900	300
③ Throughput (Tons/Day)	+50, −50	100	150	50

*Newsprint – Rich Fraction Yield from "Light" Fraction

FIGURE VI-12 SENSITIVITY TO KEY VARIABLES OF THE OPERATING COST FOR SEPARATION OF NEWSPRINT – RICH FRACTION FROM MSW

MSW appears to have little cost advantage over the source segregation/dealers system. Reclamation from MSW will not be practiced widely between now and 1983; accordingly, any price forecasting is necessarily a matter of "guesstimating."

In general, however, the rate of change in the supply and demand appears to be the single most important influence on waste paper prices.* Except for the high-value pulp substitute and high-quality deinking grades, waste paper is not transported long distances; thus, regional supply/demand factors are more significant than are national averages.

Some other, more specific findings also emerge quite clearly from this analysis:

- The sharp increase in waste paper prices that occurred in 1973 to early 1974 was caused by a number of coincident circumstances, including a sudden increase in domestic and foreign demand and deficient supply channels. Transportation is a significant factor in the total delivered cost, and its influence upon dealers' purchase prices should be measured on a regional and not a national basis. The rapid growth of West Coast exports to some 140,000 tons, which corresponds to less than 1% of the total national consumption, added fully 30% to the regional demand for waste paper; the consequences of this sudden surge were predictable.
- While the high prices of the 1073 to early 1974 period have dropped sharply, they are not likely to remain at their present low level. The cost of the alternative raw material (wood fiber), the high capital cost for pulp mill construction, and the cost of solid waste disposal all contribute to increased demand and boost prices for waste paper. Thus, while there will be additional "blips" from sudden surges of new demand and "dips" from general business slumps, waste paper will continue to be a major source of fibrous raw material for both domestic and export uses.
- The growth in demand for the major waste paper grades will be quite dissimilar. The differences are influenced by the stage of development of their reuse applications.

The remainder of this section discusses the factors that influence the projected demand and hence the price of the major categories of waste paper.

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* The interpretation of these price trends is discussed in greater detail by F.L. Smith, Jr., in "Wastepaper Recycling: Review of Recent Market Demand and Supply," Pulp & Paper, Vol. 49, No. 10 (September 1975), p. 148.

2. OCC

The recent innovation of using OCC as a fiber blend in the manufacture of kraft liner is one of the few major new applications of S/F since the introduction of 100% recycled newsprint in the early 1960's. For some time, smaller kraft mills have been blending virgin kraft with OCC to make a few kraft specialty and industrial converting grades, but the tonnage used in this application was small compared with the potential in the containerboard category.

Hence, in addition to the growth of OCC in its traditional applications--bogus medium, jute liner, and as a fiber blend in recycled board and industrial converting grades--the new application of OCC as a fiber blend in kraft liner will increase the demand for this waste paper grade. The potential supply is adequate to fill these new and expanding applications, but higher prices will be required to encourage its collection. The net effect, we believe, will be a rise in price from the current low of $20-$30 per short ton, f.o.b. dealer, to $40-50 through 1975-1978. Possible new applications leading to a further increase in demand after 1977-1978 could raise prices substantially beyond that period.

3. News

The recent introduction of old news as a fiber blend in the manufacture of newsprint is another (albeit smaller) new application of S/F. Southwest Forest Industries is installing deinking facilities for this purpose in Snowflake, Arizona, and Publishers Paper Company in Oregon recently announced plans to blend up to two-thirds S/F with virgin fiber. Other small, nonintegrated paper mills (e.g., Manistique Paper Company at Manistique, Michigan) have been blending S/F with virgin fiber in the manufacture of groundwood specialty papers; however, the tonnage potentials in these historical applications were much smaller than in newsprint manufacture by the larger mills. Hence, in addition to the growth of old news in its traditional applications--100% recycled newsprint, and as a fiber blend in groundwood specialties and recycled folding boxboard--its use as a fiber blend in newsprint will increase the demand for this type of waste paper. An adequate amount is available, but the price will have to rise to stimulate the supply, particularly from the more remote and less populated regions that are now only marginally economically attractive. From the present low of some $10-20 per ton, f.o.b. dealer, we expect the price to increase to $30-40 through the 1975-1978 period. Obviously, regional differences will continue, and temporary fluctuations will be created by sudden demands for new supply or general economic conditions.

4. P/S and High Grade Deinking

The prices of P/S and high-grade deinking will almost certainly rise. As reported previously, new facilities for using these grades are being built, and existing ones are being expanded. Because of the lack of sufficient market pulp manufacturing facilities, both in this country and abroad, these waste paper products are bound to become highly competitive.

The growing demand for pulp-substitute and high-quality deinking grades is likely to stimulate additional supplies of these grades from new sources. Government agencies are now planning to introduce programs for the source segregation of high-quality deinking grades.* New technology is also being developed to recover high-quality deinking (equivalent to colored ledger) from office waste.**

The prices of the numerous grades included in this category are expected to follow trends in the price of market pulp, although remaining lower by some $30-60 per ton (the cost of reprocessing and cleaning the S/F). As the supply of these grades from traditional sources is finite, new sources must be found to sustain the growth.

5. Mixed Waste

Mixed waste papers are used principally to make recycled folding boxboard and construction papers. Unlike the situation with OCC and old news, where new applications are rapidly increasing demand, the demand for mixed waste is tied to the consumption of established paper and paperboard products. The fact that this consumption has grown significantly more slowly than the average for the industry tends to depress the price of mixed waste.

On the other hand, waste paper is also being recovered for its fuel value, so there is a viable alternative use for this material. It is worth $6 to $12 per ton, depending upon the cost of fossil fuel. At $1 per million Btu's for fossil fuel, the net fuel value of mixed waste is about $8 per ton.

The net effect of these conflicting forces, one of which would depress and the other increase its price, is to cancel each other. As shown, there is an ample supply of waste paper to support current and possible new applications for mixed waste paper. We do not believe the recovery facilities for reclaiming waste paper as a fuel supplement will be built fast enough in the next 3 to 5 years to make any significant dent in the overall supply. Subsequent to 1980, the practice for recovering low-value waste paper for its fuel value may be sufficiently established to drive up the price of mixed waste to its fuel replacement value.

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* SCS Engineers, Inc., "Analysis of Source Separate Collection of Recyclable Solid Waste: Office Separation Systems," U.S. Environmental Protection Agency (in preparation; to be published in Spring of 1976.)

** F.D. Iannazzi, "Technical Developments that May Increase the Use of Secondary Fiber," 1975 Secondary Fibers Testing Conference, Madison, Wisconsin, September 16-18, 1975.

SECTION VII

AVAILABILITY OF WASTE PAPER

This section deals with the cost and availability of waste paper. It includes an assessment of the historical, present, and projected availability of the major waste paper grades by geographic regions and the cost components of paper stock delivered to consuming mills. The analysis is based upon published and unpublished information and on interviews with waste paper suppliers, public officials, and management of paper companies that use this fiber resource.

A. GENERAL APPROACH

To project the availability of waste paper, one must first correlate the various waste paper grades with the paper and paperboard products from which they originate. The future supply can then be determined by projecting the market demand for the original products. We used 1977 and 1983 as the interim years for projecting the demand, and hence the theoretical potential supply of waste paper.

Since waste paper is a solid waste material and not manufactured to rigid specifications, the correlation between original products and waste paper grades is not always distinct. The correlation between containerboard and newsprint on the one hand and OCC and old news on the other is quite satisfactory; that for pulp substitute, deinking, and mixed waste papers is significantly less distinct. In Table VII-1 we have attempted to correlate the original products and the corresponding waste paper grades. Note that all types of original products are found in the mixed waste paper category; thus, unlike the other major waste paper grades, the identity of the original products is not evident from this grade designation. For purposes of this analysis, however, we have assumed that mixed waste is composed of printing and writing grades; hence, the potential supply can be correlated with the consumption of those original products. If other assumptions were used regarding the composition of this grade, the theoretical supply would be different.

Table VII-2 summarizes the 1973 U.S. consumption of paper and paperboard by the major functional groups used in this study and projects their respective growth for 1977 and 1983. These figures (which were given earlier in Chapter III and are repeated here for convenience) represent the total theoretical supply of waste paper for the studied time periods.

To estimate waste paper reuse in the United States by 1977, we have used API capacity survey data. Since engineering and construction usually require 2-1/2 to 3 years to bring a major new project on stream, the data gathered in 1974 provide a sound basis for projecting the consump-

TABLE VII-1

SOURCES OF WASTE PAPER STOCKS AND THEIR RECYCLE APPLICATIONS

Source (Functional Group)	Waste Paper Stock*	Recycle Application
1. Containerboard	OCC, Mixed	Functional Groups: 1, 4b, 6, 7, 8**
2. Groundwood Paper	News, DI (GW) Mixed	Functional Groups: 1,2,3,4,6,7,8**
3. Tissue and Other Machine Creped Paper	P/S, DI(CP) Mixed	Functional Groups: 2,3,5,6,7
4. Folding Boxboard		Functional Groups:
a) Solid Bleached	P/S, DI(CP)	a) 3,5,8**
b) Combination	Mixed	b) 1,4,6,7
5. Printing, Writing and Related	P/S, DI(CP) Mixed Office Waste, Mixed Printer's Waste	Functional Groups: 2,3,4,5,6,7
6. Industrial Packaging, Converting, and Miscellaneous	Mixed, P/S	Functional Groups: 1,3 (unbleached kraft-tissue) 4,6,7
7. Construction Paper and Paperboard	N.A. (internal recycle)	N.A. (internal recycle)
8. Market Pulp	N.A.	Functional Groups: 1,2,3,5

*OCC = Old corrugated containers
DI = Deinking
P/S = Pulp substitutes
CP = Chemical pulp
GW = Groundwood

**Market Pulp manufactured from preselected grades of paper stock has been postulated but is not currently a significant factor

N.A. = Not applicable

TABLE VII-2

U.S. DEMAND PROJECTIONS, 1973-1983

Functional Group	1973 (MM tons)	Average Growth Rate (%/yr)	1977 (MM tons)	Average Growth Rate (%/yr)	1983 (MM tons)
Containerboard	17.7	3.0	20.0	3.8	25.0
Groundwood	12.2	2.6	13.6	2.6	15.8
Tissue	4.0	3.0	4.5	2.5	5.2
Folding Boxboard	7.7	2.0	8.3	2.0	9.4
Printing, Writing and Related	11.9	3.5	13.6	3.5	16.8
Industrial Packaging and Converting	7.6	2.9	8.5	2.9	10.1
Construction Paper and Board	5.9	3.5	6.9	3.5	8.5
TOTALS	67.0	3.1	75.4	3.1	90.8

SOURCES: U.S. Department of Commerce (1973) and Arthur D. Little, Inc., projections.

tion of secondary fiber in 1977. However, the projection cannot be precise, as there will inevitably be some additional previously unannounced or incremental expansion and some plans could be cancelled or postponed. General economic activity in 1977 will also have an important effect on reuse.

The analysis for 1977 is predicated on announced new capacity; that for 1983 simply assumes that the rate of reuse will continue to grow at the same rate between 1977 and 1983 as it is projected to grow from 1973 to 1977. The purpose of making that assumption was to determine whether the potential supply could sustain the substantial rate of growth that is expected to occur in the 1973-77 period. Note that the derived level of recycling was not used to estimate the likely level of secondary fiber use in 1983. Ultimately, for the 1983 projection, we used other factors that were identified and evaluated in the study, such as competitive process economics, product quality level, possible deficiency in market pulp supply, and comparative prices of pulpwood and waste paper. (See Section X.)

In addition to estimating the amount of waste paper to be reused in the United States by 1977 and 1983, we have also projected export tonnage to derive the total "recovery rate" (as defined in Section V) for each major grade by major geographic area. In this section we have simply assumed that the exports of waste paper will increase by about 8% per year through the studied period. This assumption grossly understates the doubling of export tonnage that occurred between 1973 and 1974 (from 700,000 to 1.4 million tons). In Section X (Analysis of Data), we use a higher export tonnage to reflect our belief that while it may not be economically attractive to reuse the recoverable tonnage of waste paper in the United States, there will be increased export opportunities for this material.

Using actual 1973 data and these assumptions, we have developed an overall fiber balance for 1973 and 1977 in Figures VII-1 and VII-2 respectively. The analysis reveals that even with the projected substantial increase in S/F recovery between 1973 and 1977, the potential theoretical supply — i.e., the amount of solid waste -- will increase from 43 million tons to 47 million tons by 1977. Table VII-3 shows the derivation of the quantity of permanent stock and non-recoverable given in Figure VII-1.

Some of the factors influencing the potential recovery apply to all grades, while others are specific to the individual grade under consideration. The factors considered in this analysis are discussed below.

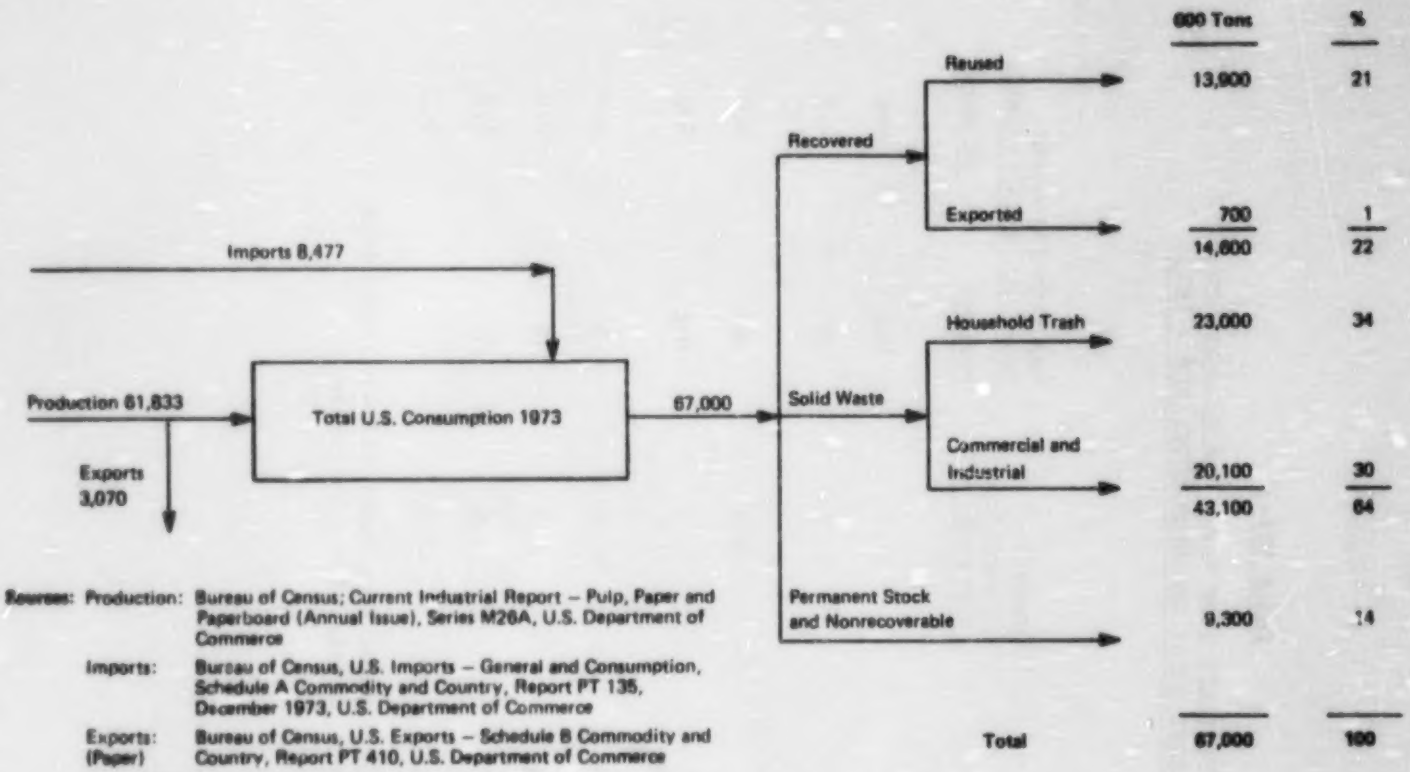
Since only the more populous areas can support an economic collection system, population concentration is a key factor in this assessment. Accordingly, we have calculated the percentage of each state's population that resides in counties of over 100,000; this percentage is called the Population Concentration Factor (PCF). (With only a few exceptions, the PCF is about equal to the percentage of a state's total population

TABLE VII-3

IDENTIFICATION OF PAPER GRADES GOING TO PERMANENT STOCK AND NONRECOVERABLE - 1973

Functional Group	Domestic Consumption (MM tons)	Paper to Permanent Stock or Nonrecoverable	
		Percent	MM tons
Containerboard	17.7	Neg	Neg
Groundwood Paper	12.3	5	0.6
Tissue and Other Machine Creped Paper	4.0	50	2.0
Folding Boxboard	7.3	Neg	Neg
Printing, Writing & Related	11.8	5	0.6
Industrial Packaging	7.3	10	0.8
Construction	6.6	80	5.3
TOTAL	67.0		9.3

Sources: Consumption figures from Table III-45; other data are Arthur D. Little, Inc., estimates


Imports 8,477
Production 61,833
Exports 3,070
Total U.S. Consumption 1973
67,000
Recovered
Solid Waste
Permanent Stock and Nonrecoverable
Reused
Exported
Household Trash
Commercial and Industrial
Total
000 Tons
%
13,900
21
700
1
14,600
22
23,000
34
20,100
30
43,100
64
9,300
14
67,000
100

Sources: Production: Bureau of Census; Current Industrial Report – Pulp, Paper and Paperboard (Annual Issue), Series M26A, U.S. Department of Commerce

Imports: Bureau of Census, U.S. Imports – General and Consumption, Schedule A Commodity and Country, Report PT 135, December 1973, U.S. Department of Commerce

Exports: (Paper) Bureau of Census, U.S. Exports – Schedule B Commodity and Country, Report PT 410, U.S. Department of Commerce

Waste Paper Reused: American Paper Institute, Statistics of Paper and Paperboard 1974

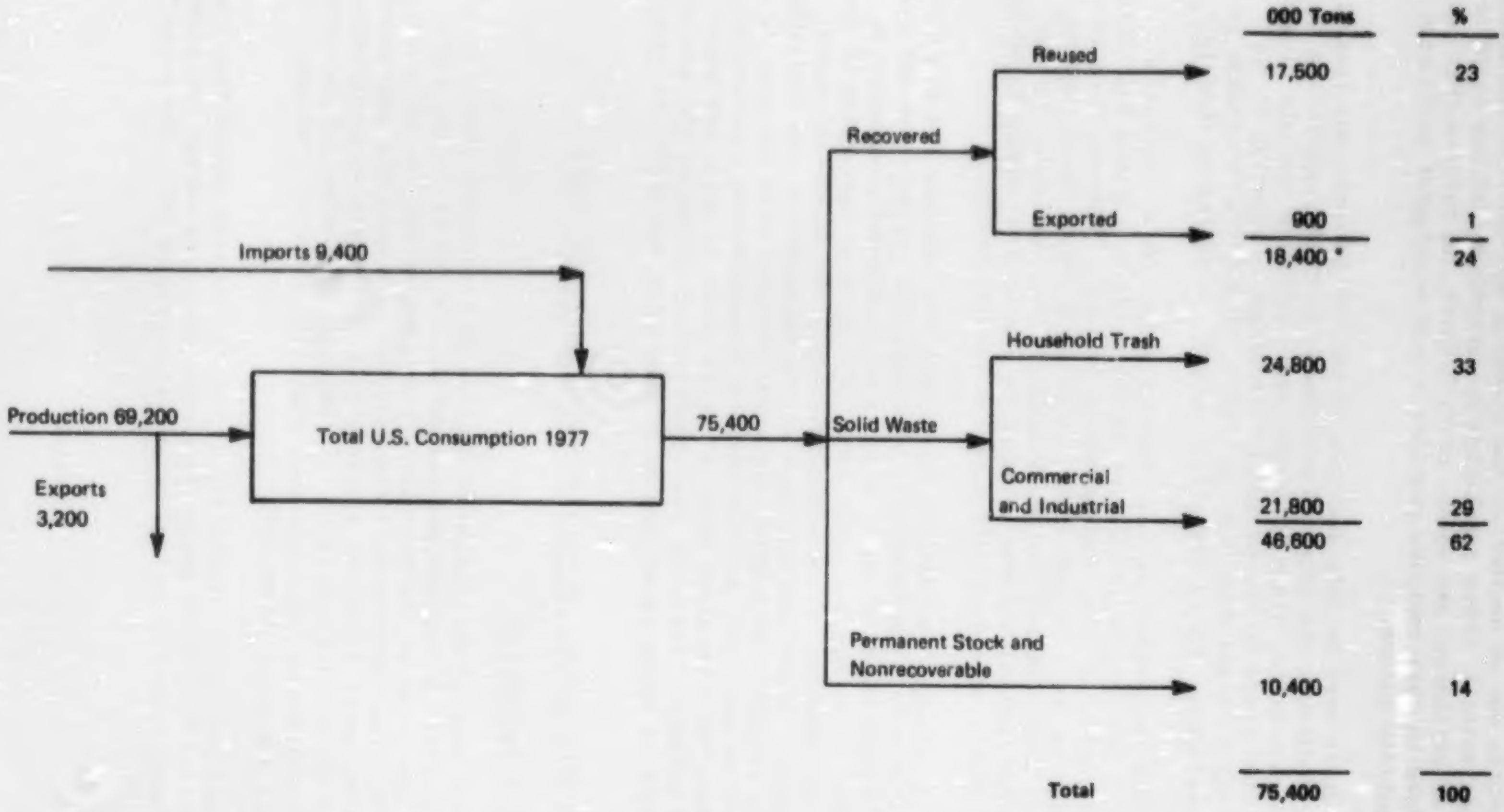
Waste Paper Exported: Bureau of Census, Current Industrial Report – Pulp, Paper and Paperboard, Series M26A, U.S. Department of Commerce

Solid Waste (Household Trash): G.C. Myers, *Paper Trade Journal* 155(35): 32(1971)

Permanent Stock and Nonrecoverable: R. Glassey and V. Gupta, "A Linear Programming Analysis of Paper Recycling," *Management Science*, Vol. 21, No. 4, December 1974, P. 392, Reported 1970 data updated by Arthur D. Little, Inc.

Solid Waste (Commercial and Industrial): Net amount after appropriate allowance for other areas of deposition, Arthur D. Little, Inc., calculations.

FIGURE VII–1 OVERALL FIBER BALANCE FOR THE UNITED STATES IN 1973


000 Tons
%
Imports 9,400
Production 69,200
Exports
3,200
Total U.S. Consumption 1977
75,400
Recovered
Reused
17,500
23
Exported
900
1
18,400 *
24
Solid Waste
Household Trash
24,800
33
Commercial
and Industrial
21,800
29
46,600
62
Permanent Stock and
Nonrecoverable
10,400
14
Total
75,400
100

* Assumes that domestic reuse as indicated in API Capacity Survey data will reach 17.5 million tons and that exports will reach 900,000 tons. While exports may be low, the API numbers (which were made before the stretchout) may be high; thus, this should be a reasonable estimate of the overall amount recovered.

Source: Arthur D. Little projections based upon previous listed sources. (See Figure VII–1)

FIGURE VII–2 OVERALL FIBER BALANCE FOR THE UNITED STATES IN 1977

that live within one or another of the Standard Metropolitan Statistical Areas in that state.) Other population concentration indices could be used, such as population per square mile; however, we believe that the PCF as derived in this analysis provides a more meaningful indication of this important factor.

The other factor used in this analysis is the "G" (Generation) factor. This factor indicates the relative employment in the manufacturing industries in each state, since it is the ratio of the percentage of such workers in that state to the national percentage. Depending on the state, its value ranged from 0.15 to 1.46 in 1972. The "G" factor is useful in evaluating OCC availability, as will be explained shortly.

In making this assessment, we calculated the data on an individual state basis. The results are listed in Table VII-4, grouped according to the nine individual U.S. Census Bureau regions. However, because of variations in the size and other characteristics of these regions, certain ones were combined (or subdivided) in our analysis. For example, the New England and Middle Atlantic states were combined, while Alaska and Hawaii were split off from the Pacific region.

"Collectable tonnage," as defined in Section V-A, denotes the quantity of waste paper that is economically available for recovery but not necessarily for economical reuse in a paper or paperboard manufacturing application. It is not a precise term but simply an indication of the magnitude and location of the potential supply for additional waste paper recovery. Other factors, such as the magnitude of the available supply, its proximity to a mill, its value compared with the cost of an alternative raw material, and its utility in papermaking applications, all influence the economical reuse of waste paper in paper and paperboard applications. These factors are discussed following the analysis of the amount of waste paper that is economically available for recovery.

B. COLLECTABLE TONNAGE OF OLD CORRUGATED CONTAINERS (OCC)

1. Bases of Evaluation

Although the name of this category implies post-consumer waste, it is generally defined to include pre-consumer waste (double-lined kraft cuttings) generated at the corrugated box plant as well as old corrugated boxes. While the term may be misleading, we have used the conventional nomenclature, since these two discrete paper stock grades are combined in most of the statistical data. In assessing the potential recovery of OCC, we considered the respective characteristics of each and, ultimately, its reuse potential.

As indicated previously (Table VII-1), OCC is derived solely from the containerboard functional group; hence the projected demand for those products became the theoretical potential supply of OCC. The potential

TABLE VII-4

SELECTED STATE CHARACTERISTICS INFLUENCING THE AVAILABILITY OF WASTE PAPER

BASIS: 1972 population

State	Population			Population Concentration		Area			Industrial Activity ("G" Factor)
	Total	%	Rank	P.C.F. (%)	Rank (by P.C.F.)	Square Miles	%	Rank	
Maine	1,029	0.5	38	29.1	42	33,215	0.9	39	1.202
New Hampshire	771	0.4	41	30.7	40	9,304	0.3	44	1.214
Vermont	462	0.2	48	0	49	9,609	0.3	43	0.934
Massachusetts	5,787	2.8	10	96.3	1	8,257	0.2	45	1.022
Rhode Island	968	0.5	39	80.8	12	1,214	<0.05	50	1.258
Connecticut	3,082	1.5	24	83.1	8	5,009	0.1	48	1.236
NEW ENGLAND	12,099	5.8	(8)	78.4	(3)	66,608	1.8	(9)	
New York	18,366	8.8	2	93.0	2	49,576	1.4	30	0.887
New Jersey	7,367	3.5	8	65.3	21	7,836	0.2	46	1.161
Pennsylvania	11,926	5.7	3	90.2	4	45,333	1.3	33	1.227
MIDDLE ATLANTIC	37,659	18.1	(2)	86.7	(1)	102,745	2.8	(8)	
Ohio	10,783	5.2	6	82.2	10	41,222	1.1	35	1.289
Indiana	5,291	2.5	11	61.5	25	36,291	1.0	38	1.391
Illinois	11,251	5.4	5	75.9	17	56,400	1.6	24	1.112
Michigan	9,082	4.4	7	80.3	13	58,216	1.6	23	1.332
Wisconsin	4,520	2.2	16	56.1	28	56,154	1.6	26	1.214
EAST NORTH CENTRAL	40,926	19.7	(1)	74.5	(4)	248,283	6.9	(6)	
Minnesota	3,896	1.9	19	63.7	23	84,068	2.3	12	0.873
Iowa	2,883	1.4	25	29.7	41	56,290	1.6	25	0.947
Missouri	4,753	2.3	14	85.3	6	69,686	1.9	19	0.978
North Dakota	632	0.3	45	20.6	45	70,665	2.0	17	0.258
South Dakota	679	0.3	44	14.6	48	77,047	2.1	16	0.432
Nebraska	1,525	0.7	35	49.7	32	77,227	2.1	15	0.674
Kansas	2,258	1.1	30	24.7	44	82,264	2.3	14	0.795
WEST NORTH CENTRAL	16,626	8.0	(6)	53.9	(8)	517,247	14.3	(3)	

TABLE VII-4 (cont'd)

SELECTED STATE CHARACTERISTICS INFLUENCING THE AVAILABILITY OF WASTE PAPER

BASIS: 1972 population

State	Population			Population Concentration		Area			Industrial Activity ("G" Factor)
	Total	%	Rank	P.C.F. (%)	Rank (by P.C.F.)	Square Miles	%	Rank	
Delaware	565	0.3	46	89.3	5	2,057	0.1	49	1.166
Maryland	4,056	1.9	17	51.4	31	10,577	0.3	42	0.800
District of Columbia	748	0.4	N.A.	100.0	N.A.	67	Neg.	N.A.	0.199
Virginia	4,764	2.3	13	42.8	35	40,817	1.1	36	0.953
West Virginia	1,781	0.9	34	51.7	30	24,181	0.7	41	0.913
North Carolina	5,214	2.5	12	45.4	33	52,586	1.5	28	1.417
South Carolina	2,665	1.3	26	44.9	34	31,055	0.9	40	1.460
Georgia	4,720	2.3	15	57.4	27	58,876	1.6	21	1.068
Florida	7,259	3.5	9	85.1	7	58,560	1.6	22	0.516
SOUTH ATLANTIC	31,772	15.3	(3)	59.1	(6)	278,776	7.7	(5)	
Kentucky	3,299	1.6	23	38.2	37	40,395	1.1	37	1.056
Tennessee	4,031	1.9	18	65.3	21	42,244	1.2	34	1.242
Alabama	3,510	1.7	21	58.4	26	51,609	1.4	29	1.202
Mississippi	2,263	1.1	29	19.6	46	47,716	1.3	32	1.267
EAST SOUTH CENTRAL	13,103	6.3	(7)	48.8	(9)	181,964	5.0	(7)	
Arkansas	1,978	0.9	32	37.0	38	53,104	1.5	27	1.202
Louisiana	3,720	1.8	20	62.4	24	48,523	1.3	31	0.630
Oklahoma	2,634	1.3	27	53.5	29	69,919	1.9	18	0.680
Texas	11,649	5.6	4	77.8	15	267,338	7.4	2	0.733
WEST SOUTH CENTRAL	19,981	9.6	(5)	67.7	(5)	438,884	12.1	(4)	
Montana	719	0.3	43	25.4	43	147,138	4.1	4	0.497
Idaho	756	0.4	42	16.6	47	83,557	2.3	13	0.807
Wyoming	345	0.2	49	0	49	97,914	2.7	9	0.292
Colorado	2,357	1.1	28	73.1	18	104,247	2.9	8	0.606
New Mexico	1,065	0.5	37	32.8	39	121,666	3.4	5	0.335
Arizona	1,945	0.9	33	76.9	16	113,909	3.2	6	0.581
Utah	1,126	0.5	36	81.1	11	84,916	2.3	11	0.615
Nevada	527	0.3	47	79.4	14	110,540	3.1	7	0.155
MOUNTAIN	8,840	4.2	(9)	59.1	(6)	863,887	23.9	(2)	

TABLE VII-4 (Cont'd)

SELECTED STATE CHARACTERISTICS INFLUENCING THE AVAILABILITY OF WASTE PAPER

BASIS: 1972 population

State	Population			Population Concentration		Area			Industrial Activity ("G" Factor)
	Total	%	Rank	P.C.F. (%)	Rank (by P.C.F.)	Square Miles	%	Rank	
Washington	3,443	1.7	22	66.4	20	68,192	1.9	20	0.839
Oregon	2,182	1.0	31	67.0	19	96,981	2.7	10	0.922
California	20,468	9.8	1	90.8	3	158,693	4.4	3	0.835
Alaska	325	0.2	50	42.1	36	586,412	16.2	1	0.351
Hawaii	809	0.4	40	82.7	9	6,450	0.2	47	0.357
PACIFIC	27,227	13.1	(4)	85.1	(2)	916,728	25.4	(1)	
U. S. TOTAL	208,232	100	N.A.	71.4	N.A.	3,615,122	100	N.A.	

NOTE: ( ) Rank by region

Source: Populations and areas - Statistical Abstract of the United States, U.S. Department of Commerce, 1973
PCF and "G" factors - Arthur D. Little, Inc., calculations

supply is projected to grow from some 17.7 million tons actually consumed in 1973 to 20.0 million and 25.0 million tons respectively in 1977 and 1983.

2. Regional Supply/Demand Patterns

a. Double-Lined Kraft Cuttings

The quantity of double-lined kraft cuttings and other preconsumer waste can be correlated directly with the projected demand for containerboard. Typically, the quantity that is discarded is 8% to 14% of the tonnage of the incoming raw materials--linerboard and corrugating medium. The low end of the range (8%) is characteristic of box plants making long runs of standard-size boxes; the high end of the range (14%) is characteristic of smaller box plant operations making short runs of highly specialized boxes. We assumed an average overall scrap factor of 10%.

A second assumption in deriving the quantity and location of the availability of double-lined kraft cuttings is that the containerboard is converted in the same Census Bureau region in which it is used and discarded. In view of the bulky characteristics of corrugated containerboard, this is a reasonable assumption. These two assumptions enable us to derive the quantity of double-lined kraft cuttings from the projected regional demand for containerboard.

Figure VII-3 shows the geographic location of corrugated box plants, and Table VII-5 lists estimated data on the availability of double-lined kraft cuttings in 1973. The relative amounts and geographic distribution of this waste product are expected to remain essentially the same between now and 1983; thus they are not shown separately but incorporated within the overall estimate of OCC availability.

b. Old Corrugated Containers

The potential resource from post-consumer waste is significantly larger than the preconsumer fraction but more difficult to quantify. The basic approach is to take the national average consumption of containerboard and modify it to reflect the population concentration and industrial activity of the studied region (state) compared with the national average. (See Appendix C-2.)*

The previously derived Population Concentration Factor was applied to that portion of the theoretical total consumption used in the retail

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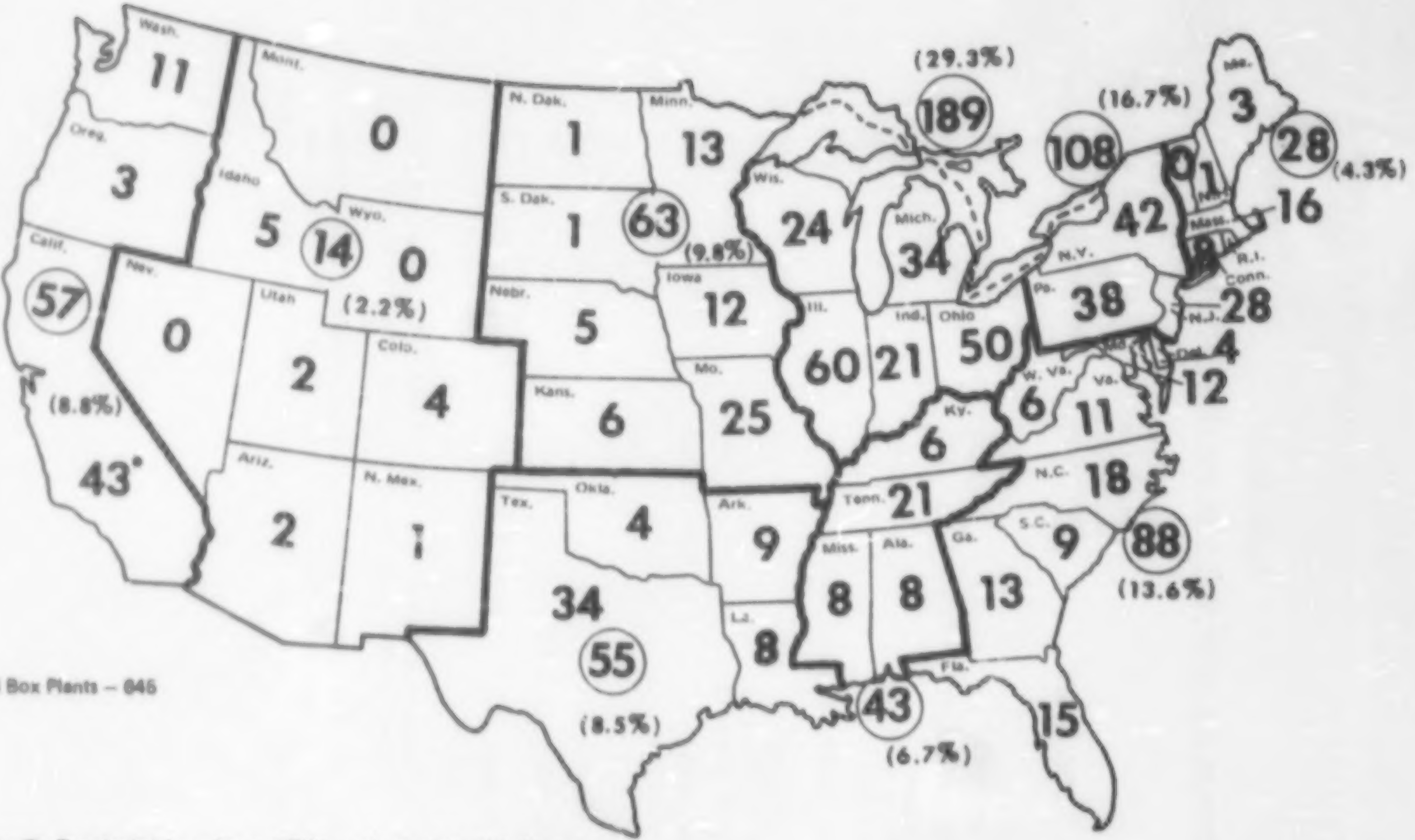
*An alternative, more refined method of calculation that does not rely on national average consumption is explained in Section VII-F. Examination of the tables and graphs in that section shows that while the alternative method produces somewhat different figures for the individual states, the regional data are essentially unchanged. Therefore, we have elected to base our analysis on the method originally used and discussed here.


Wash. 11
Oreg. 3
Calif. 43*
57
(8.8%)
Nev. 0
Idaho 5
Mont. 0
Wyo. 0
14
(2.2%)
Utah 2
Colo. 4
Ariz. 2
N. Mex. 1
N. Dak. 1
S. Dak. 1
Nebr. 5
Kans. 6
Minn. 13
Iowa 12
Mo. 25
63
(9.8%)
Tex. 34
Okla. 4
Ark. 9
La. 8
55
(8.5%)
Wis. 24
Mich. 34
Ill. 60
Ind. 21
Ohio 50
189
(29.3%)
Ky. 6
Tenn. 21
Miss. 8
Ala. 8
43
(6.7%)
W. Va. 6
Va. 11
N.C. 18
S.C. 9
Ga. 13
Fla. 15
Md. 12
Del. 4
88
(13.6%)
N.Y. 42
Pa. 38
N.J. 28
108
(16.7%)
Me. 3
N.H. 1
Vt. 0
Mass. 16
R.I. 8
Conn. 28
28
(4.3%)

Total Box Plants – 645

Notes: ○ Denotes total number and (%) box plants within U.S. Bureau of Census Region

- * Includes 2 in Hawaii.

Source: Lockwood's Directory – 1973.

FIGURE VII–3 LOCATION OF CORRUGATED BOX PLANTS IN THE UNITED STATES

TABLE VII-5

SOURCES AND AVAILABILITY OF NEW KRAFT CUTTINGS, 1973

Census Region	Containerboard Consumption (000 tons)	Scrap* (000 tons)	% of Total Available Scrap
New England	1,032	103	6
Middle Atlantic	3,208	321	18
TOTAL NORTHEAST	4,240	424	24
East North Central	3,499	350	20
West North Central	1,402	140	8
TOTAL NORTH CENTRAL	4,901	490	28
South Atlantic	2,688	269	15
East South Central	1,096	110	6
West South Central	1,683	168	9
TOTAL SOUTH	5,467	547	30
Mountain	730	73	4
Pacific	2,266	227	13
Alaska and Hawaii	94	9	1
TOTAL MOUNTAIN & PACIFIC	3,090	309	18
TOTAL U.S.	17,700	1,770	100

SOURCE: Consumption based upon U.S. Bureau of Census data, reapportioned to major geographic regions by ADL.

* Assumed to equal 10% of region's containerboard consumption. Includes all discards from converting plants, including new corrugated cuttings, new double kraft lined corrugated and new kraft lined corrugated cuttings.

sector of the economy. Statistics compiled by the Fibre Box Association (Table VII-6) indicate that 42.2% of the total container usage occurs in the retail sector; hence, the collectable tonnage from this source is:

[theoretical quantity] x [percentage used in the retail sector (i.e., 42.2%)] x [PCF]

In a similar manner, the amount of containerboard used in manufacture is adjusted to reflect the individual state characteristics. In this case, the ratio of the state's manufacturing activity is compared to the national average to develop the "G" factor. Hence, the collectable tonnage from this source is expressed as:

[theoretical quantity] x [percentage used in the manufacturing sector (i.e., 57.8%)] x ["G" factor]

The total collectable tonnage is the sum of these quantities. Table VII-7 is an example of the calculation made for an individual state; similar calculations were made for each of the 50 states and projected to 1977 and 1983 with appropriate adjustments to reflect market demand projections for containerboard.

Table VII-8 summarizes the apparent consumption of the original containerboard, the collectable tonnage, and the recovery rate of OCC in 1973. (Note that in Tables VII-8, -9, and -10 the term "OCC" includes both old corrugated boxes and box-plant waste.) The analysis reveals that in 1973 on a national basis, the "collectable tonnage" amounted to some 15.3 million, or about 86% of the apparent 17.7 million ton consumption of the original products. It is also clear that the ratio of collectable tonnage to apparent consumption is highly variable, ranging from 102% in the East North Central region to 59% in the Mountain region. The ratio in Alaska and Hawaii is even lower than in the Mountain region but is not considered significant because of the comparatively small quantity available and its remote location.

The apparent anomaly in the East North Central region, where the collectable tonnage exceeds the apparent consumption, simply reflects that the calculated use of containerboard in that region is greater than the national average. Similarly, some of the data presented later (e.g., P/S and deinking) will indicate a regional recovery greater than the apparent consumption, because the region is a net importer of the studied waste paper grade.

The tonnage of OCC that is reused in each region is based on actual mill survey data gathered by API. However, data are not available to identify the paper stock grade exported from specific census regions; accordingly, we postulated these data on the basis of actual total aggregate data reported for 1973 in Section V. Since the quantity of total U.S. exports

TABLE VII-6

SHIPMENTS OF CONTAINERBOARD PRODUCTS BY END USE, 1972

I. Directly Proportional To Population Data	Percent
Food and kindred products	5.7
Meat products	5.8
Dairy products	1.9
Canning and preserving fruits, vegetables and sea foods	6.1
Bakery goods	1.7
Confectionery and related products	1.3
Beverages	3.7
Fresh fruits and vegetables	1.7
Tobacco	0.7
Apparel	1.3
Furniture and fixtures	3.5
Printing and publishing, except books	1.1
Drugs	0.5
Soaps, detergents, cosmetics, toiletries	2.4
Household appliances	3.1
Radio and television sets	0.4
Toys, sporting and athletic goods	1.3
	42.2
II. Directly Proportional to Industrial Activity*	57.8

*Fibre boxes consumed in manufacturing, e.g., automotive assembly.

Source: Extracted from "Classifications of Shipments by End Use, 1972" in annual report of Fibre Box Association.

TABLE VII-7

SAMPLE CALCULATION OF COLLECTABLE TONNAGE FOR OLD CORRUGATED CONTAINERS

Basis: Base Year 1973
National Avg. per Capita Consumption - 152.5 lb[a]
Sample State - Massachusetts (5,826,000 population)

	(000 tons)	
	Gross	Collectable
Total Consumed in State		
Per capita consumption x state population	(A)	
$152.5 \text{ lb} \times \frac{\text{ton}}{2000 \text{ lb}} \times 5{,}826{,}000$	444	
Collectable Tonnage		
Amount from Retail		
Gross (A) x % used in Retail[b]	(B)	
444 x 42.2%	187	
Collectable=(B) x PCF[c]		(C)
187 x 96.3		180
Amount from Manufacture		
Gross (A) x % used in Mfg[b]	(D)	
444 x 57.8	257	
Collectable=(D) x "G" [d]		(E)
257 x 1.022		262
TOTAL COLLECTABLE TONNAGE (C + E) (Excludes double-lined kraft clippings)		442

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[a] Excludes converting waste, which is assumed to be 10% of total consumption.

[b] Shipment of Containerboard Products by End Use, from Annual Report of Fibre Box Association, 1972

[c] "PCF" is that portion of a state's population located in counties of over 100,000

[d] "G" (Generation Factor) is the ratio of the state percent of employees in manufacturing classifications and the U.S. total percent in manufacturing - Ref U.S. Department of Commerce Publication Country Business Patterns, 1972.

TABLE VII-8

SUMMARY - CONSUMPTION AND AVAILABILITY OF OCC BY MAJOR GEOGRAPHIC REGION - 1973

Region	Apparent Consumption Of Original Products[1]	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage
			% of Apparent Consumption	Reused	Exported from U. S.	Total	% of Collectable Tonnage	% of Apparent Consumption	
	(000 tons)	(000 tons)		(000 tons)	(000 tons)	(000 tons)			(000 tons)
New England	1,032	981	95	334	30	364	37	35	617
Middle Atlantic	3,208	3,095	96	968	76	1,044	34	32	2,051
NORTH EAST	4,240	4,076	96	1,302	106	1,408	34	33	2,668
East North Central	3,499	3,585	102	1,738	45	1,783	50	51	1,802
West North Central	1,402	1,033	74	208	-	208	20	15	825
NORTH CENTRAL	4,901	4,618	94	1,946	45	1,991	43	41	2,627
South Atlantic	2,688	2,048	76	719	8	727	35	27	1,321
East South Central	1,096	875	80	302	-	302	34	28	573
West South Central	1,683	1,247	74	267	-	267	21	16	980
SOUTH	5,467	4,170	76	1,288	8	1,296	31	24	2,874
Mountain	730	435	59	30	None	30	7	4	405
Pacific (Mainland)	2,266	1,941	86	726	90	816	42	36	1,125
Alaska & Hawaii	94	48	41	Neg	None	Neg	Neg	0	48
MOUNTAIN & PACIFIC	3,090	2,424	78	756	90	846	35	27	1,578
TOTAL U.S.	17,700	15,290	86	5,292	250	5,542	36	31	9,748

SOURCES:
1. Total - API "Statistics of Paper"; regional allocations - ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - U.S. Census Bureau data with ADL allocaton of total exports by major grade and point of debarkation (see Table V-4).

TABLE VII-9

SUMMARY - CONSUMPTION AND AVAILABILITY OF OCC BY MAJOR GEOGRAPHIC REGION - 1977

Region	Apparent Consumption Of Original Products[1]	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage
	(000 tons)	(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U. S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	(000 tons)
New England	1,166	1,108	95	366	40	406	37	35	700
Middle Atlantic	3,625	3,497	96	1,179	100	1,279	36	35	2,218
NORTH EAST	4,791	4,605	96	1,545	140	1,685	36	35	2,920
East North Central	3,954	4,051	102	2,425	60	2,485	61	63	1,566
West North Central	1,584	1,167	74	237	-	237	20	15	930
NORTH CENTRAL	5,538	5,218	94	2,662	60	2,722	52	49	2,496
South Atlantic	3,037	2,314	76	1,257	10	1,267	55	42	1,047
East South Central	1,238	990	80	432	-	432	44	35	558
West South Central	1,092	1,409	74	416	-	416	30	22	993
SOUTH	6,177	4,712	76	2,105	10	2,115	45	34	2,597
Mountain	825	492	59	(30)	None	30	6	4	462
Pacific (Mainland)	2,560	2,193	86	(967)	120	1,087	50	42	1,106
Alaska & Hawaii	106	54	51	None	None	None	0	0	54
MOUNTAIN & PACIFIC	3,492	2,739	78	997	120	1,117	41	32	1,622
TOTAL U.S.	20,000	17,277	86	7,308	330	7,639	44	38	9,638

SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: **Reused** - API Capacity Survey data, pp. 21, 22
   Exported - extrapolated from 1973 figures at 3% per year.

TABLE VII-10

SUMMARY - CONSUMPTION AND AVAILABILITY OF OCC BY MAJOR GEOGRAPHIC REGION - 1983

Region	Apparent[1] Consumption Of Original Products (000 tons)	Collectable Tonnage[2] (000 tons)		Recovery of Waste Paper[3] Reused (000 tons)					Net Collectable Tonnage (000 tons)
			% of Apparent Consumption		Exported from U. S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	
New England	1,458	1,385	95	480	50	530	38	36	855
Middle Atlantic	4,531	4,371	96	1,540	130	1,670	38	37	2,701
NORTH EAST	5,989	5,756	96	2,020	180	2,200	38	37	3,556
East North Central	4,942	5,064	102	3,820	80	3,900	77	79	1,164
West North Central	1,980	1,459	74	400	-	400	27	20	1,059
NORTH CENTRAL	6,922	6,522	94	4,220	80	4,300	66	62	2,222
South Atlantic	3,796	2,892	76	2,590	10	2,600	90	68	292
East South Central	1,548	1,238	80	900	-	900	73	58	338
West South Central	2,378	1,761	74	900	-	900	51	38	861
SOUTH	7,721	5,890	76	4,390	10	4,400	75	57	1,491
Mountain	1,031	615	59	50	None	50	8	5	565
Pacific (Mainland)	3,200	2,741	86	1,490	160	1,650	60	52	1,091
Alaska & Hawaii	132	68	51	None	None	None	0	0	68
MOUNTAIN & PACIFIC	4,365	3,424	78	1,540	160	1,700	50	39	1,724
TOTAL U.S.	25,000	21,596	86	12,170	430	12,600	58	50	8,996

SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - extrapolated by major geographic region at same rate as reported for 1973-77 period.
   Exported - extrapolated from 1973 figures at 8% per year.

is small compared with the amount reused (less than 5%), the overall effect of error introduced via the allocation of exports is slight. Of particular importance is the export pattern on the Pacific region, since fully 50% of the exports are from that region; field interviews of exporters were made by ADL representatives to get an approximation of the quantity of each grade leaving that area.

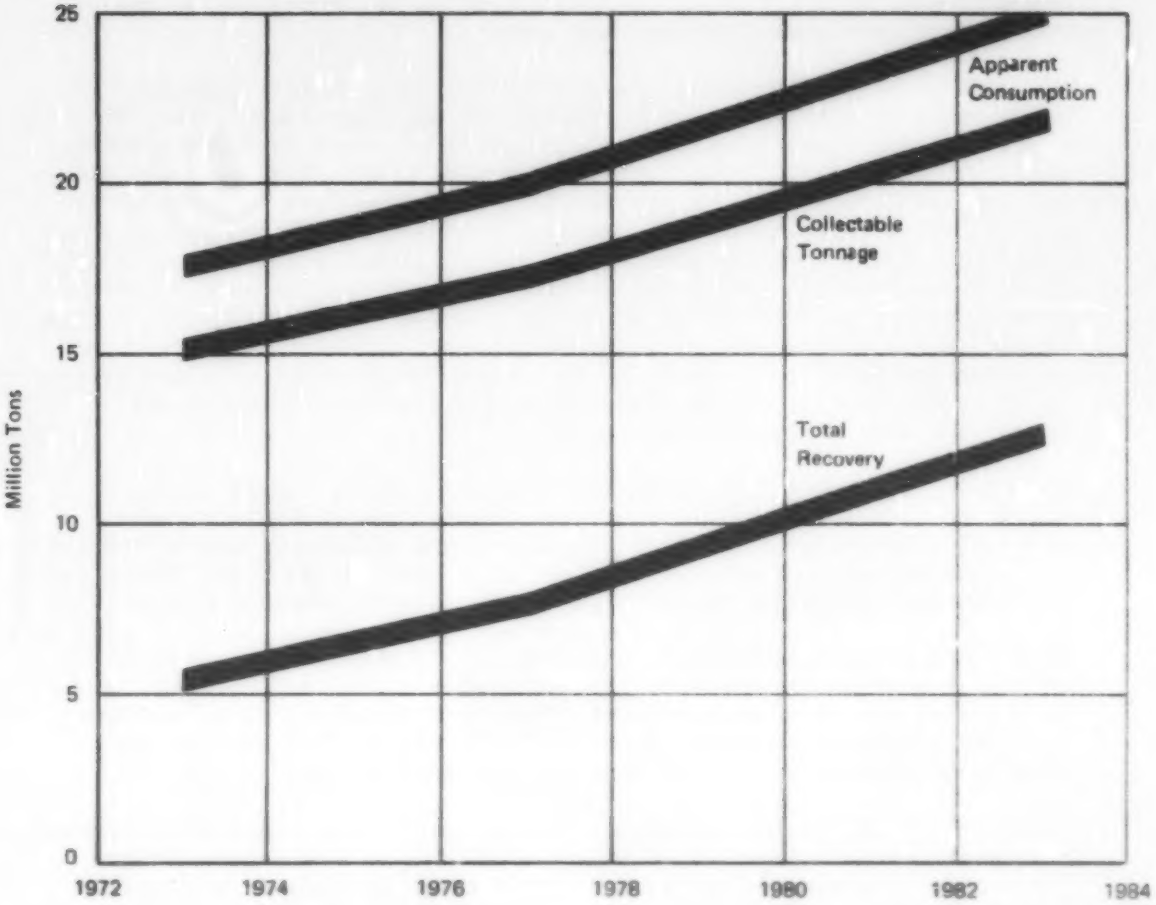
Although we have reported recovery rates for each region, expressed as percentages of both collectable tonnage and apparent consumption, we recognize that there is appreciable shipment of these products between regions. For example, many populous areas of New England are much closer to a recycled board mill in the New York City area than to other areas of the Middle Atlantic states. Hence, it is appropriate to assume--and field interviews have confirmed--that interregional movements of waste paper do occur which cannot be accurately documented. A more meaningful interpretation is obtained by assessing the data for a larger geographic region, e.g., by combining the New England and Middle Atlantic regions into the Northeast. In practice, of course, recycle patterns are determined by the cost of transporting waste paper to the consuming mill, not by the size of census regions.

With the caveat that the calculated recovery rate by census region is simply an indication and not a precise figure, the analysis reveals that net collectable tonnage of OCC (i.e., the additional amount available for recovery) was 9.7 million tons in 1973. Tables VII-9 and VII-10 present the same analysis projected for 1977 and 1983 respectively.

Figure VII-4 summarizes and illustrates the relationship of apparent consumption of containerboard, the calculated collectable tonnage, and recovery of OCC on a national basis from 1973 to 1983. Total recovery includes estimates exports, which are projected to grow from an estimated 250,000 tons in 1973 to some 450,000 tons by 1983.

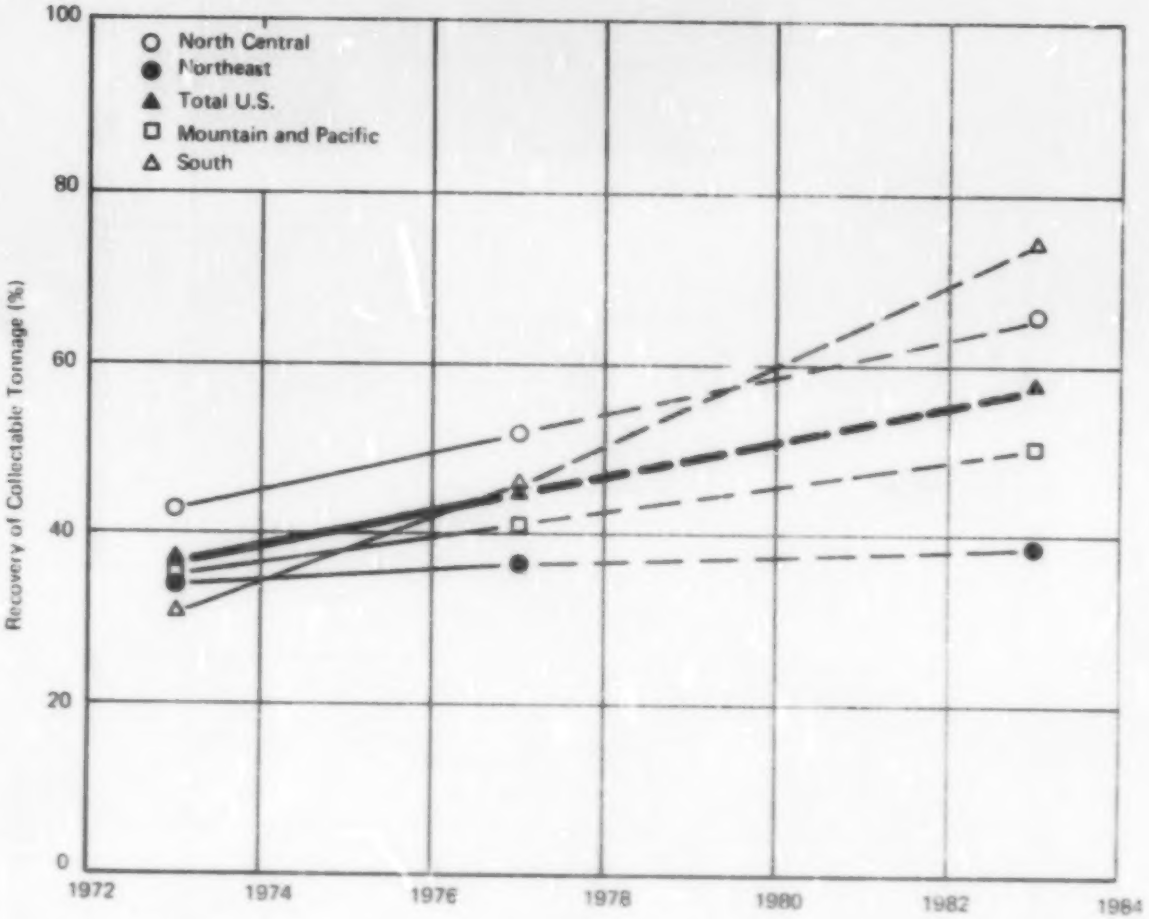
Figure VII-5 indicates, by region, the recovery rates required to achieve the growth pattern illustrated previously. The analysis reveals that the rate of recovery is increasing faster than the rate of projected demand for the original product, as indicated by increased recovery rates. Moreover, to sustain the increased recovery rate at the same level in 1977-1983 as is projected to occur in 1973-1977 would necessitate unprecedented recovery rates, particularly in the South and North Central regions. There is no industry experience to indicate that such recovery rates are achievable on a sustained basis.

Figure VII-6 is a graphic representation of the data in Tables VII-8, -9, and -10. This presentation makes it clear that while the recovery of OCC in the South between 1973 and 1977 will increase significantly faster than in any other region on a percentage basis, the North Central region will continue to lead in terms of actual tonnage.



Sources: Tables VII–8, –9, and –10.

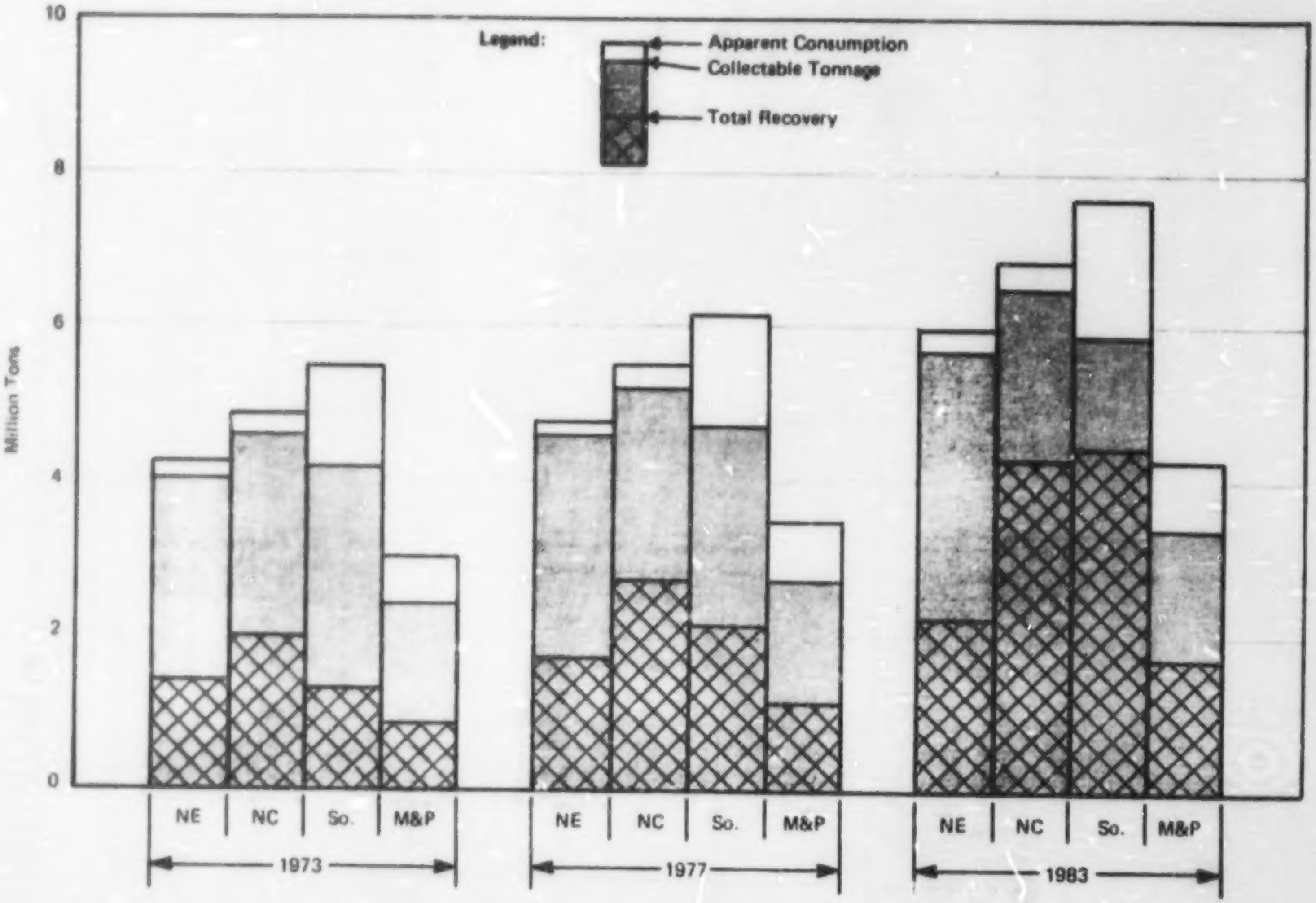
FIGURE VII–4 AVAILABILITY AND RECOVERY OF OLD CORRUGATED CONTAINERS IN THE UNITED STATES



Basis: Assumes that the quantity of OCC recovered will continue to increase at the same rate in 1977–1983 as it is projected to increase in 1973–1977.

Source: Tables VII-8, -9, and -10.

FIGURE VII–5 RECOVERY OF OLD CORRUGATED CONTAINERS BY MAJOR GEOGRAPHIC REGIONS, 1973–1983



Source: Tables VII-8, -9, and -10.

FIGURE VII–6 CONSUMPTION AND AVAILABILITY OF OLD CORRUGATED CONTAINERS BY MAJOR GEOGRAPHIC REGIONS, 1973 TO 1983

Again, there is no industrial experience to indicate that the recovery rates shown for 1983 are obtainable. The analysis was included simply to illustrate what the recovery rate would be if the same rate of growth projected for 1973-1977 were to continue through 1983.

3. Summary of Analysis

a. Pertinent from 1973 to 1977

- The recovery of OCC is projected to increase from some 5.5 million tons (31% of apparent consumption) to 7.6 million tons (38% of apparent consumption) during this period;
- The North Central currently has and will continue to have the highest recovery rate and actual usage of any census region;
- The recovery of OCC is growing faster in the South than in any other region and will surpass all but the North Central by 1977; and
- In spite of the substantial growth of OCC recovery, the net collectable tonnage of OCC will be some 9.6 million tons.

b. Pertinent from 1977 to 1983

- To maintain the 1973-1977 rate of increased OCC usage, the North Central and South would need to recover at levels of 62% and 57% (of apparent consumption). The attainability of these rates has not been demonstrated on a sustained basis.

C. COLLECTABLE TONNAGE OF NEWS

1. Bases of Evaluation

As the name implies, "news" (or "old news") is derived from used newsprint; hence, the theoretical supply can be correlated directly with that one original product. In 1973, U.S. consumption (hence supply of news) was about 10.5 million tons; this is expected to grow to some 11.7 million and 13.6 million tons by 1977 and 1983 respectively.

As will be recalled in the transformation of the individual paper stock grades into major waste paper categories (Table V-5), news also includes two types of preconsumer waste--groundwood shavings and over-issue news. In 1970, the combined tonnage of these two preconsumer grades was less than 2% of the total theoretical supply. Reportedly, the percentage of over-issue news has dropped recently as prices for newsprint rose. Because the preconsumer paper stock grades are such a small percentage of the total theoretical supply, they were combined with the post-consumer news grades.

The key factor to assessing the potential recovery of news is the PCF. Earlier studies by the Forest Products Laboratory have established that about 80% of all newsprint is discarded as household trash; only a small portion is discarded by the commercial/industrial sector. Thus, the potential availability of old news may be assessed by studying population distribution patterns.

The American Newspaper Publishers Association (ANPA) lists newsprint consumption by state.* According to ANPA, daily newspapers accounted for 84% of the total newsprint usage in 1973. With this percentage and their data on daily newsprint consumption exclusively for newspaper, we derived the total newsprint consumption for all purposes (including weekly newspapers, commercial printing, shopping news, etc.). We then applied the calculated PCF to the derived newsprint consumption to estimate the collectable tonnage in each state. These figures were extrapolated to 1977 and 1983 in proportion to the newsprint demand projection reported in Section III. The state-by-state calculations are contained in Appendix C-3; only the summary regional data are discussed in this section.

As stated previously, since waste paper is a mixture of grades, it does not lend itself to precise analysis. For example, in calculating the net collectable tonnage of news, the projected old news recovery is subtracted from apparent consumption of newsprint; however, a substantial amount of news ultimately goes into mixed waste (averaging 10% of mixed waste) and is hence available for recovery from that grade. The estimate of net collectable tonnage is thus overstated by the quantity that appears in mixed waste.

2. Regional Supply/Demand Patterns

Table VII-11 summarizes the apparent consumption of newsprint (the original product), the collectable tonnage, and the recovery of news in 1973. The analysis reveals that on a national basis the collectable tonnage is some 8.1 million tons, or about 77% of the 10.5 million tons of the apparent newsprint usage. This ratio of potential recovery is only slightly less than the 86% potential for OCC, which ranks first among all grades. Table VII-11 also shows the high variability in potential recovery rate as affected by the PCF, ranging from 88% in the congested population areas of the Northeast to 69% in the more sparsely populated areas of the South.

Total recovery (i.e., domestic reuse and exports) was about 2.7 million tons, corresponding to 26% of the apparent consumption, or 33% of the collectable tonnage. Not shown in this tabulation is the amount recovered from mixed waste, which was about 300,000 tons in 1973, making the overall recovery about 30% of the total apparent consumption.

The Northeast is by far the single largest user of waste news, recovering about 1.0 million tons or about 36% of the apparent consumption. The South has the lowest actual tonnage usage and recovery rates. The net collectable tonnage (5.4 million) indicates a much larger supply is available.

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*"Newsprint Statistics," ANPA, Newsprint & Traffic Bulletin No. 12, April 12, 1974, p. 27

Tables VII-12 and -13 present a similar analysis for 1977 and 1983 respectively. The analysis for 1977 is predicated on announced new capacity; that for 1983 assumed a continuation of the rate projected for 1973-1977. This assumption was made simply to determine whether the potential supply would grow fast enough to sustain the rate of growth that is expected to occur in the 1973-1977 period.

Figure VII-7 summarizes and illustrates the relationship of apparent consumption of newsprint and the recovery of waste news on a national basis from 1973 to 1983. Again, the recovery as reported here includes estimates of exports (particularly from the Pacific region) but does not include waste news recovered from mixed waste papers.

Figure VII-8 indicates, by region, the recovery rates required to achieve the growth patterns illustrated previously. It reveals that the recovery rates for the Northeast and North Central regions are substantially greater than the national average; continued growth in these areas is likely to keep pace with the additional supply. The Mountain and Pacific region is expected to achieve the greatest percentage increase in recovery.

Figure VII-9 graphs the data in Tables VII-11, -12, and -13; it shows that despite changes in their respective rates of recovery, the regions will retain their relative standings in terms of actual tonnage.

3. Summary of Analysis

a. Related to 1973-1977 Period

- The recovery of old news is expected to increase from some 2.7 million tons to 3.1 million tons during this period, thus maintaining the recovery rates of about 25% of the apparent consumption of the original product, or about 33% of the collectable tonnage;
- The Northeast and North Central regions are by far the greater users of this material, both in actual tonnage and percent recovery;
- The net collectable tonnage is projected to increase from 5.4 million tons in 1973 to 6.0 million tons by 1977. At 1.8 million tons, the South will have the largest segment of the under-utilized resource.

b. Related to 1977-1983 Period

- If the use of old news continues to increase in this period as it did in 1973-1977, the highest recovery rate will be experienced in the Northeast and North Central regions.

TABLE VII-11

SUMMARY - CONSUMPTION AND AVAILABILITY OF WASTE NEWS BY MAJOR GEOGRAPHIC REGION - 1973

Region	Apparent[1] Consumption Of Original Products (000 tons)	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage (000 tons)
		(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U. S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	
New England	552	472	86	165	30	195	41	35	277
Middle Atlantic	2,229	1,968	88	739	76	815	41	36	1,153
NORTH EAST	2,781	2,439	88	904	106	1,010	41	36	1,430
East North Central	2,105	1,583	75	676	45	721	46	34	862
West North Central	653	390	60	60	-	60	15	9	330
NORTH CENTRAL	2,758	1,973	72	736	45	781	40	28	1,192
South Atlantic	1,658	1,203	73	228	8	236	20	14	968
East South Central	402	210	52	98	-	98	47	24	112
West South Central	938	662	70	84	-	84	13	9	578
SOUTH	2,998	2,075	69	410	8	418	20	14	1,658
Mountain	424	289	68	30	None	30	10	7	259
Pacific (Mainland)	1,491	1,289	86	376	90	466	36	31	823
Alaska & Hawaii	52	32	62	0	None	0	0	0	32
MOUNTAIN & PACIFIC	1,967	1,610	82	406	90	496	31	25	1,114
TOTAL U.S.	10,504	8,097	77	2,456	250	2,706	33	26	5,394

OURCES: 1. American Newspaper Publishers Association.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
Exported - U.S. Census Bureau data with ADL allocation of total exports by major grade and point of debarkation (see Table V-4).

TABLE VII-12

SUMMARY - CONSUMPTION AND AVAILABILITY OF WASTE NEWS BY MAJOR GEOGRAPHIC REGION - 1977

Region	Apparent Consumption Of Original Products[1]	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage
			% of Apparent Consumption	Reused	Exported from U. S.	Total	% of Collectable Tonnage	% of Apparent Consumption	
	(000 tons)	(000 tons)		(000 tons)	(000 tons)	(000 tons)			(000 tons)
New England	615	526	86	172	40	212	40	34	314
Middle Atlantic	2,485	2,194	88	806	100	906	41	37	1,288
NORTH EAST	3,100	2,720	88	978	140	1,118	41	36	1,602
East North Central	2,346	1,765	75	758	60	818	46	35	947
West North Central	728	435	60	65	-	65	15	9	370
NORTH CENTRAL	3,074	2,200	72	823	60	883	40	29	1,317
South Atlantic	1,848	1,342	73	267	10	277	21	15	1,065
East South Central	448	234	52	105	-	105	45	23	129
West South Central	1,046	738	70	98	-	98	13	9	640
SOUTH	3,342	2,314	69	470	10	480	21	14	1,834
Mountain	473	322	68	43	None	43	13	9	279
Pacific (Mainland)	1,662	1,437	86	440	120	560	39	34	877
Alaska & Hawaii	58	36	62	None	None	None	0	0	36
MOUNTAIN & PACIFIC	2,193	1,795	82	483	120	603	34	28	1,192
TOTAL U.S.	11,700	9,029	77	2,754	330	3,084	34	26	5,945

SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - extrapolated from 1973 figures at 8% per year.

TABLE VII-13

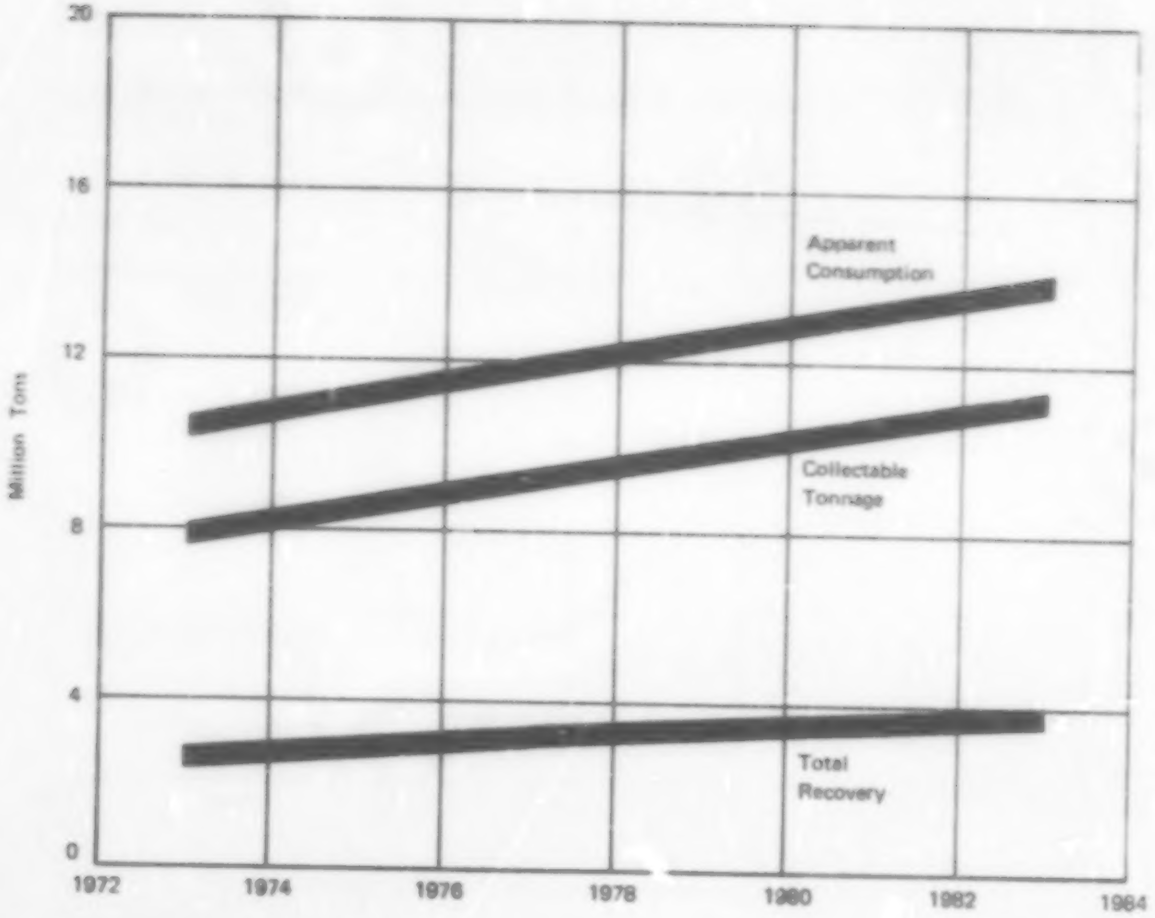
SUMMARY - CONSUMPTION AND AVAILABILITY OF WASTE NEWS BY MAJOR GEOGRAPHIC REGION - 1983

Region	Apparent Consumption Of Original Products[1] (000 tons)	Collectable Tonnage[2] (000 tons)	Collectable Tonnage[2] % of Apparent Consumption	Recovery of Waste Paper[3] Reused (000 tons)	Recovery of Waste Paper[3] Exported from U. S. (000 tons)	Recovery of Waste Paper[3] Total (000 tons)	Recovery of Waste Paper[3] % of Collectable Tonnage	Recovery of Waste Paper[3] % of Apparent Consumption	Net Collectable Tonnage (000 tons)
New England	714	611	86	200	50	250	41	35	361
Middle Atlantic	2,887	2,550	88	930	120	1,050	41	36	1,500
NORTH EAST	3,601	3,161	88	1,130	170	1,300	41	36	1,861
East North Central	2,726	2,052	75	910	70	980	48	36	1,072
West North Central	846	506	60	80	-	80	16	9	426
NORTH CENTRAL	3,572	2,558	72	990	70	1,050	41	30	1,498
South Atlantic	2,147	1,560	73	340	10	350	22	16	1,210
East South Central	520	272	52	130	-	130	48	25	142
West South Central	1,215	858	70	120	-	120	14	10	738
SOUTH	3,882	2,690	69	590	10	600	23	16	2,090
Mountain	550	374	68	50	None	50	16	11	314
Pacific (Mainland)	1,931	1,670	86	610	140	750	45	39	920
Alaska & Hawaii)	67	42	62	None	None	None	0	0	42
MOUNTAIN & PACIFIC	2,548	2,086	82	670	140	810	39	32	1,276
TOTAL U.S.	13,600	10,495	77	3,380	390	3,770	35	28	6,725

SOURCES: 1. ADL estimates.

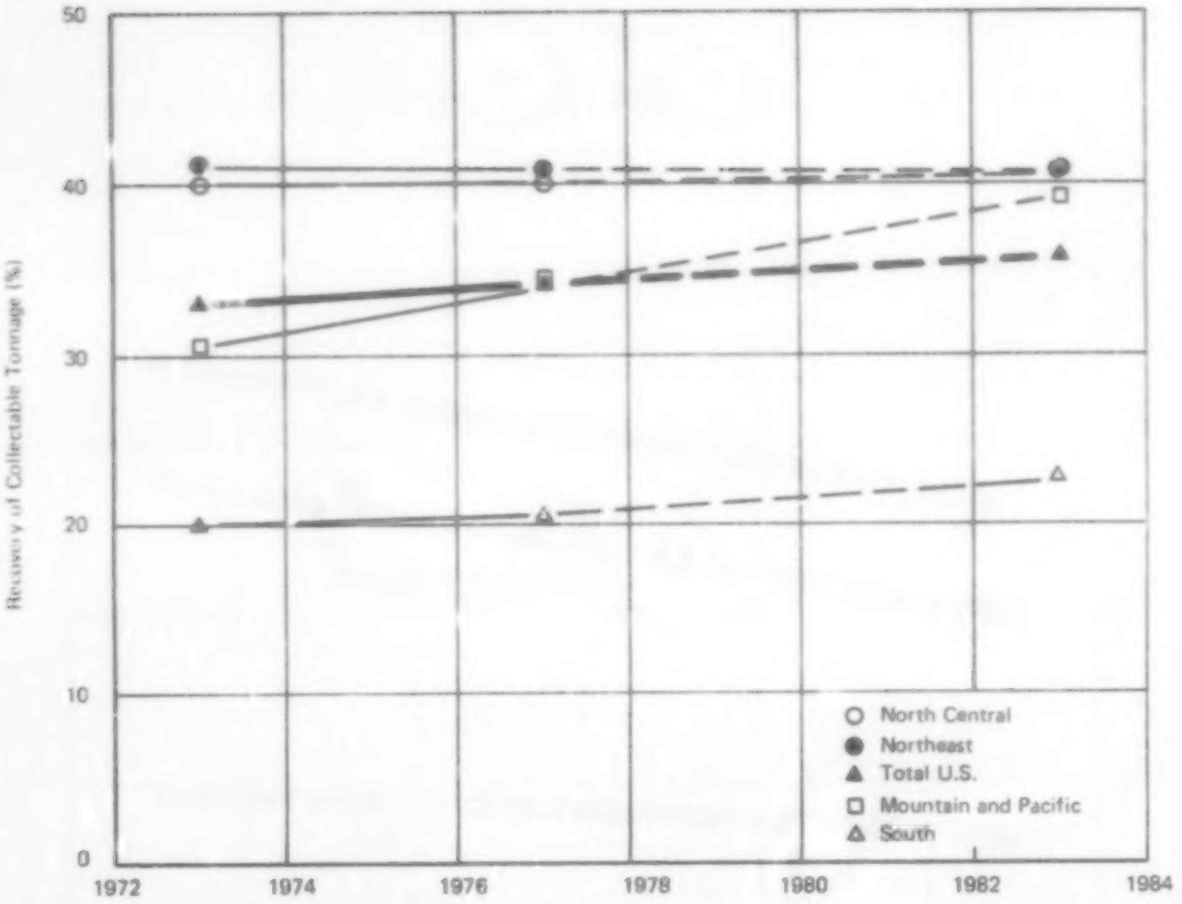
2. ADL estimates (see supporting data for methodology).

3. Recovery of Waste Paper: Reused - extrapolated by major geographic region at same rate as reported for 1973-77 period.
Exported - extrapolated from 1973 figures at 8% per year.



Sources: Tables VII–11, –12, and –13.

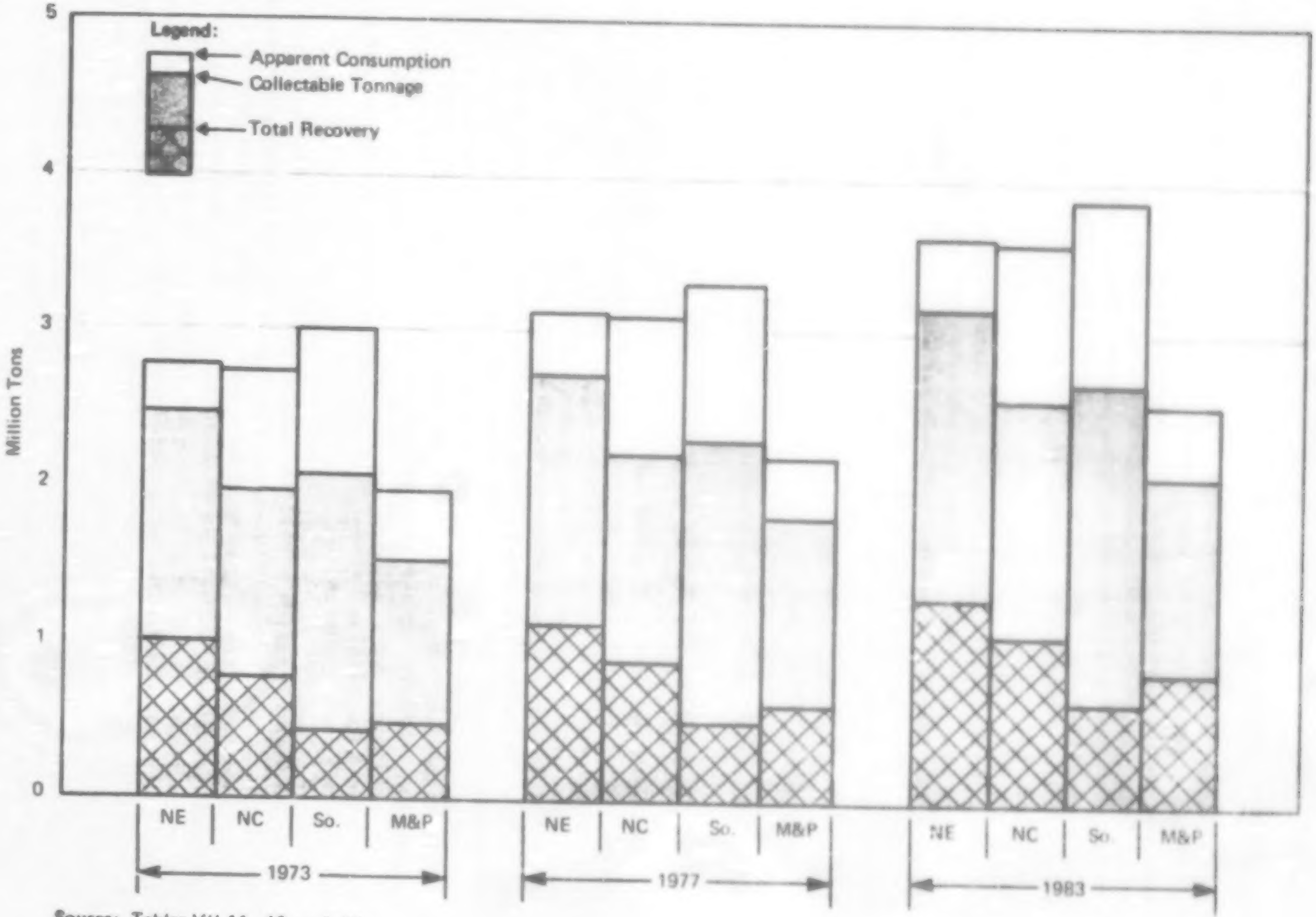
FIGURE VII–7 AVAILABILITY AND RECOVERY OF OLD NEWS IN THE UNITED STATES



Basis: Assumes that the quantity of news recovered will continue to increase at the same rate in 1977–1983 as it is projected to increase in 1973–1977.

Source: Tables VII-11, -12, and -13.

FIGURE VII-8 RECOVERY OF OLD NEWS BY MAJOR GEOGRAPHIC REGIONS, 1973–1983



Source: Tables VII-11, -12, and -13.

FIGURE VII-9 CONSUMPTION AND AVAILABILITY OF OLD NEWS BY MAJOR GEOGRAPHIC REGION, 1973 TO 1983

D. COLLECTABLE TONNAGE OF P/S AND HIGH-GRADE DEINKING GRADES

1. Bases of Evaluation

A wide variety of original products from several functional groups contribute to the supply of waste paper in this category. The analysis presented earlier, which grouped the numerous Paper Stock Institute grades into five major waste paper categories, indicated that the principal sources are printing and writing papers (Functional Group 5), industrial packaging, converting, and miscellaneous papers (Functional Group 6), and pre-consumer (converter) waste from the conversion of these products.

Accordingly, with minor exceptions, the demand projections of the original products contained in these groups were used as the basis for deriving the theoretical supply of pulp substitute and high-grade deinking. For the amount derived from the printing and writing category, the regional distribution was estimated from the reported value of printing industry shipments. The calculated regional distribution was used to allocate the total tonnage and subsequent scrap originating in each region. The analysis thus reflects the well-established fact that the bulk of this industry is located in the Middle Atlantic, the East North Central, and the Pacific (California) regions.

We made two simplifying assumptions in estimating the total P/S and high-quality deinking grades from "other converting papers": (1) all of the converter waste is economically available for recovery and (2) the supply of these grades comes exclusively from converting operations. Obviously, these assumptions do not reflect actual industry practice; all of the converter waste is not economically available, and only about 70% of these grades are converter waste. (See Table V-5 and Figure V-4.) Nevertheless, we believe that the simplifications provide a reasonable basis for projecting total availability. The volume of the original products consumed and the amount of scrap material associated with their manufacture were allocated to geographic regions in proportion to their populations. Table VII-14 shows the derivation of the estimates for 1973; for the 1977 and 1983 estimates, these quantities were simply increased in proportion to the projected demands for the original products.

As the subsequent analysis will indicate, the supply of P/S and high-quality deinking from post-consumer waste must be increased substantially if the demand for these grades is to be met. There are two potential areas of additional supply—beneficiation of mixed waste and improved source segregation. Techniques for the mechanical beneficiation of office waste are presently in the early development stage, but their potential is significant.* Since the initial writing of this report, EPA has been taking steps leading to the eventual source segregation of office waste

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* F.D. Iannazzi, "Technical Developments that May Increase the Use of Secondary Fiber," 1975 Secondary Fibers Testing Conference, Madison, Wisconsin, September 16-18, 1975.

TABLE VII-14

DERIVATION OF COLLECTABLE TONNAGE FOR P/S AND HIGH-GRADE DEINKING

Basis: 1973 data; all tonnages in thousands

	PRINTING AND WRITING PAPERS				OTHER CONVERTING PAPERS				TOTAL
	1	2	3	4	5	6	7	8	
CENSUS AREA	% of[(a)] Total in each Area	Total[(b)] Tons Printing Grades-U.S.	Total Tons Printing Grades-Area (1 X 2)	Tons Scrap Using 15% Factor	"Other Converting"[(c)] per capita consumption (tons)	Population[(d)] of Census Area (Thousands)	Tonnage by Area, "Other Converting" (5 X 6)	Tons Scrap using 12% Factor	Combined Scrap (4 + 8)
New England	6	12,286	737.2	110.6	0.09	12,176	1,095	131	242
Mid-Atlantic	31		3808.7	571.3		37,872	3,408	409	980
E.N.Central	25		3071.5	460.7		41,288	3,714	446	907
W.N.Central	8		982.9	147.4		16,547	1,488	178	325
S. Atlantic	9		1105.7	165.9		31,690	2,850	342	508
E.S.Central	4		491.4	73.7		12,932	1,163	140	214
W.S. Central	5		614.3	92.1		19,873	1,787	214	306
Mountain	2		245.7	35.9		8,615	775	93	130
Pacific	10		1228.6	184.3		27,845	2,505	300	486
TOTAL U.S.	100	12,286	12,286	1,843	0.09	208,888	18,783	2,253	4,096

(a) Percentages are proportional to the value of printing industry shipments in 1971 as listed in "Economic Analysis of Proposed Effluent Guidelines -- Printing Industry," U.S. Environmental Protection Agency, EPA-230/1-74-053, August 1974, p. 28.

(b) Pulp, Paper & Board, Quarterly Industry Report - April 1974

Groundwood Paper - Uncoated	1308	(000 tons)
Coated Printing & Converting	3546	
Book Paper, Uncoated	3010	
Bleached Bristols	1093	
Writing & Related	3329	
	12,286	

(Total is somewhat larger than that listed in Table III-5 because slightly different subcategories are considered here.)

(c) Statistics of Paper - 1972 API

Unbl. Kraft Pkg. & Ind. Conv. Paper	34.7
Pkg. & Ind. Converting except Unbl. Kraft	12.2
Unbl. Kraft Pkg. & Ind. Convert. Paperboard	95.5
Bleached Kraft Pkg. & Ind. Convert. Paperboard	32.3
Per-capita total (lb)	175
	(use 0.09 ton)

(d) Projections of the population of states, 1975-1990 and census populations, 1960-1970, Table I of current population reports. Series P-25, No. 477, 1972 by U.S. Dept. of Commerce, Series I-E of the Table used.

NOTE: Scrap factors are based on information from waste paper dealers and selected printing firms.

in all government offices; effective implementation of this program could increase the supply substantially.*

While we presently lack hard data on the additional supply of P/S and high-quality deinking that might be recovered from office waste by either of these techniques, we would estimate it at 4-5 million tons annually. This estimate is based on the assumptions that annual U.S. consumption of printing and writing paper is about 10 million tons and that roughly half of it is used in large commercial buildings and public agencies where recovery would be practicable.

Both source segregation and mechanical beneficiation of office waste hold promise for increasing the supply of these grades from post-consumer waste, but our discussions with dealers indicate that neither has contributed substantial volume to date. For this reason, we have not included additional tonnage that might be available from these sources in our estimates of potential supply.

2. Regional Supply/Demand Patterns

Table VII-15 summarizes the apparent consumption of the original products, the collectable tonnage, and recovery of P/S and deinking grades in 1973. It shows that on a national basis, 3.4 million tons, or 83% of the current total supply (i.e., preconsumer waste) is presently being utilized. Unlike the comparatively low-value bulk grades previously discussed (OCC and news), there are significant regional deficiencies in the supply pattern: the New England and East North Central regions must import a significant amount of their total fiber usage. Only the Middle Atlantic and West North Central regions appear to have a significant excess supply beyond regional demands. These excess supplies apparently are being transferred within their respective census regions to bring in balance the overall supply/demand pattern for the Northeast and North Central areas.

Tables VII-16 and -17 present the same analysis for 1977 and 1983 respectively. The projected demand (plus our estimated exports) appears to be growing faster than the additional new supply: the potential supply is

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*We are informed that the following give pertinent information on this subject:

- SCS Engineers, Inc., "Analysis of Source Separate Collection of Recyclable Solid Waste: Separate Collection Studies," Environmental Protection Publication SW95C.1, U.S. Environmental Protection Agency, 1974, 157 pp (Distributed by National Technical Information Service, Springfield, Va., as PB239 775).
- SCS Engineers, Inc., "Analysis of Source Separate Collection of Recyclable Solid Waste: Office Separation Systems," U.S. Environmental Protection Agency (in preparation; to be published in spring of 1976).

TABLE VII-15

SUMMARY - CONSUMPTION AND AVAILABILITY OF P/S & DEINKING GRADE BY MAJOR GEOGRAPHIC REGION - 1973

Region	Apparent Consumption Of Original Products[1]	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage
	(000 tons)	(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U. S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	(000 tons)
New England	1,800	240	13	422	Neg	422	176	23	- 180
Middle Atlantic	7,200	980	14	651	23	674	69	9	+ 306
NORTH EAST	9,000	1,220	14	1,073	23	1,096	90	12	+ 126
East North Central	6,800	900	13	1,252	Neg	1,252	140	18	- 352
West North Central	2,500	320	13	49	Neg	49	15	2	+ 271
NORTH CENTRAL	9,300	1,220	13	1,301	Neg	1,[illegible]1	107	14	- 81
South Atlantic	4,000	510	12	275	Neg	275	54	7	+ 235
East South Central	1,600	210	13	97	Neg	97	46	6	+ 113
West South Central	2,400	300	12	127	Neg	127	42	5	+ 173
SOUTH	8,000	1,020	13	499	Neg	499	50	6	+ 521
Mountain	1,000	130	13	26	Neg	26	20	3	+ 104
Pacific (Mainland)	3,600	480	13	300	160	460	96	13	+ 20
Alaska & Hawaii	100	Neg	0	Neg	Neg	Neg	0	0	Neg
MOUNTAIN & PACIFIC	4,700	610	13	326	160	486	80	10	+ 124
TOTAL U.S.	31,000	4,070	13	3,199	183	3,382	83	11	+ 690

SOURCES:
1. Total - API "Statistics of Paper"; regional allocations - ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - U.S. Census Bureau data with ADL allocating of total exports by major grade and point of debarkation (see Table V-4)

TABLE VII-16

SUMMARY - CONSUMPTION AND AVAILABILITY OF P/S & DEINKING GRADE BY MAJOR GEOGRAPHIC REGION - 1977

Region	Apparent Consumption Of Original Products (000 tons) [1]	Collectable Tonnage [2] (000 tons)	Collectable Tonnage [2] % of Apparent Consumption	Recovery of Waste Paper [3] Reused (000 tons)	Recovery of Waste Paper [3] Exported from U. S. (000 tons)	Recovery of Waste Paper [3] Total (000 tons)	Recovery of Waste Paper [3] % of Collectable Tonnage	Recovery of Waste Paper [3] % of Apparent Consumption	Net Collectable Tonnage (000 tons)
New England	2,000	270	13	493	Neg	493	182	25	- 223
Middle Atlantic	8,100	1,100	14	730	30	760	69	9	+ 340
NORTH EAST	10,100	1,370	14	1,223	30	1,253	91	12	+ 117
East North Central	7,600	1,000	13	1,561	Neg	1,561	156	20	- 561
West North Central	2,800	360	13	52	Neg	52	14	2	+ 308
NORTH CENTRAL	10,400	1,360	13	1,613	Neg	1,613	119	16	- 253
South Atlantic	4,500	370	12	294	Neg	294	52	6	+ 276
East South Central	1,800	240	13	104	Neg	104	43	6	+ 136
West South Central	2,700	340	12	153	Neg	153	45	6	+ 187
SOUTH	9,000	1,150	13	551	Neg	551	48	6	+ 599
Mountain	1,100	140	13	29	Neg	29	21	3	+ 111
Pacific (Mainland)	4,000	540	13	330	190	520	96	13	+ 20
Alaska & Hawaii	100	Neg	0	Neg	Neg	Neg	Neg	0	+ Neg
MOUNTAIN & PACIFIC	5,200	680	13	359	190	549	81	10	+ 131
TOTAL U.S.	34,700	4,560	13	3,746	220	3,966	87	11	+ 594

SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - extrapolated from 1973 figures at 8% per year.

TABLE VII-17

SUMMARY - CONSUMPTION AND AVAILABILITY OF P/S & DEINKING GRADE BY MAJOR GEOGRAPHIC REGION - 1983

Region	Apparent Consumption Of Original Products[1] (000 tons)	Collectable Tonnage[2] (000 tons)	Collectable Tonnage[2] % of Apparent Consumption	Recovery of Waste Paper[3] Reused (000 tons)	Recovery of Waste Paper[3] Exported from U. S. (000 tons)	Recovery of Waste Paper[3] Total (000 tons)	Recovery of Waste Paper[3] % of Collectable Tonnage	Recovery of Waste Paper[3] % of Apparent Consumption	Net Collectable Tonnage (000 tons)
New England	2,400	320	13	600	Neg	600	190	25	- 280
Middle Atlantic	9,700	1,310	14	900	40	940	72	10	+ 370
NORTH EAST	12,100	1,630	14	1,500	40	1,540	94	13	+ 90
East North Central	9,000	1,190	13	2,100	Neg	2,100	180	23	- 910
West North Central	3,300	430	13	100	Neg	100	23	3	+ 330
NORTH CENTRAL	12,300	1,620	13	2,200	Neg	2,200	136	18	- 580
South Atlantic	5,400	680	12	340	Neg	340	50	6	+ 340
East South Central	2,100	280	13	120	Neg	120	43	6	+ 160
West South Central	3,200	400	12	180	Neg	180	45	6	+ 220
SOUTH	10,700	1,360	13	640	Neg	640	47	6	+ 720
Mountain	1,300	170	13	40	Neg	40	24	3	+ 130
Pacific (Mainland)	4,800	640	13	390	220	610	95	13	+ 30
Alaska & Hawaii	100	Neg	0	Neg	Neg	Neg	Neg	0	Neg
MOUNTAIN & PACIFIC	6,200	810	13	430	220	650	80	10	+ 160
TOTAL U.S.	41,300	5,420	13	4,770	260	5,030	93	12	+ 390

SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - extrapolated by major geographic region at same rate as reported for 1973-77 period
   Exported - extrapolated from 1973 figures at 8% per year.

projected to increase from 4.1 million to 4.6 million tons by 1977, or about 500,000 tons, while projected recovery is estimated to increase from 3.4 million to 4.0 million, or about 600,000 tons. As a result, the recovery rate of collectable tonnage will increase from 83% to 87%.

If the increase in usage projected for the 1973-1977 period continues at the same rate in 1977-1983 some 93% of the estimated collectable tonnage will have to be recovered to sustain it. Attainment of this recovery level seems highly unlikely; therefore, new supply sources must be developed if the growth of these waste paper grades is to be maintained.

Figure VII-10 summarizes and illustrates the relationship of apparent consumption and recovery on a national basis. It is clear from this graph that a very large quantity of these waste paper grades is not being recovered.

Figure VII-11 indicates by region the recovery rates required to sustain the reported growth pattern for the P/S and deinking grades. This analysis indicates the dependence on imports by the North Central region to fill its fiber requirements. The recovery rates calculated for the other regions are understated, since they make up the deficiencies of the North Central region as well as supply their own requirements.

Figure VII-12 is a graphic representation of fiber availability and recovery in actual tonnage estimates rather than percentages.* The use of P/S and deinking fiber in the studied areas is more conveniently compared in this way.

3. Summary of Analysis

a. General

Because of the high value of these grades, we believe that many of their traditional sources (converter waste) are highly exploited. Accordingly, if additional supplies are to be secured to meet the increasing demand for these grades, new sources must be identified. Clearly, the potential rests with better exploitation of post-consumer waste via either source segregation or mechanical beneficiation of office waste. Neither of these techniques is presently yielding substantial volume, however.

b. Related to the 1973-1977 Period

- The recovery of these grades is projected to grow more rapidly than the corresponding supply, thereby increasing the recovery rate from 83% to 87% of the collectable tonnage.

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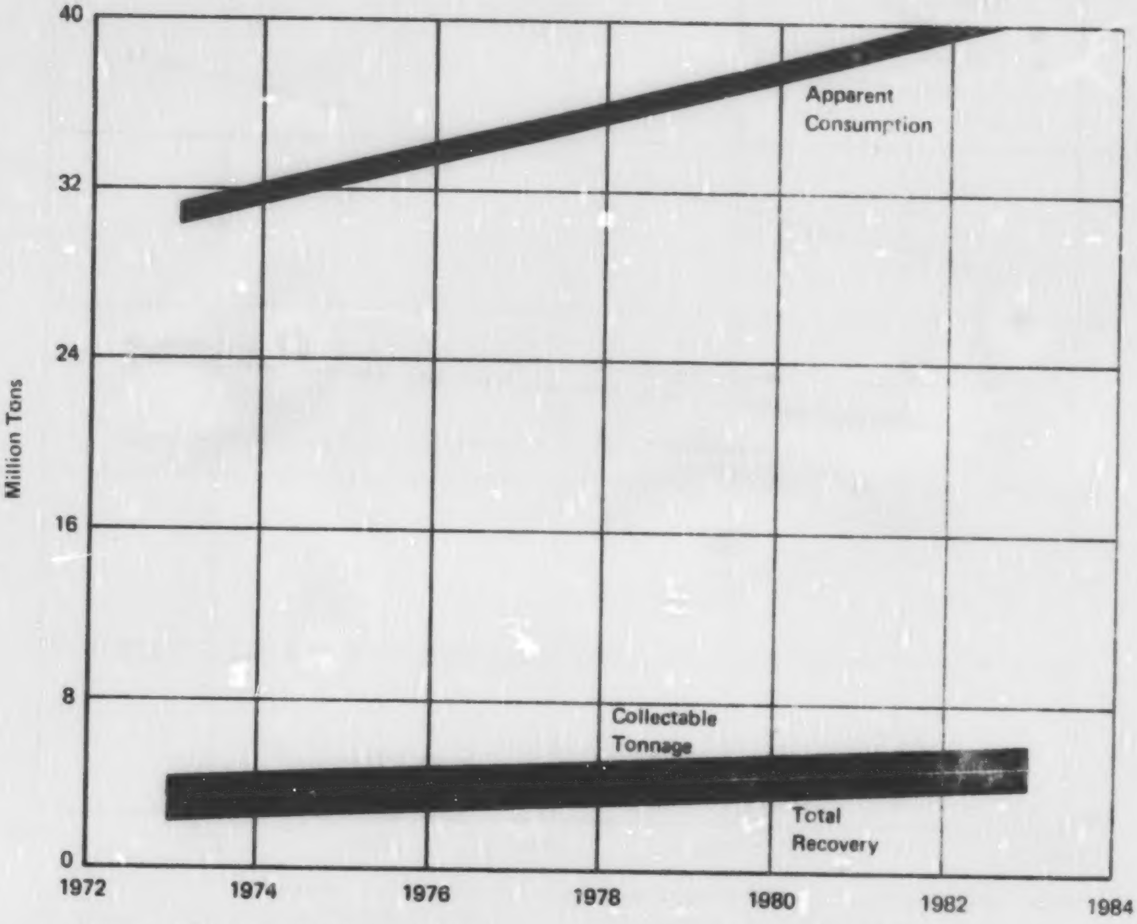
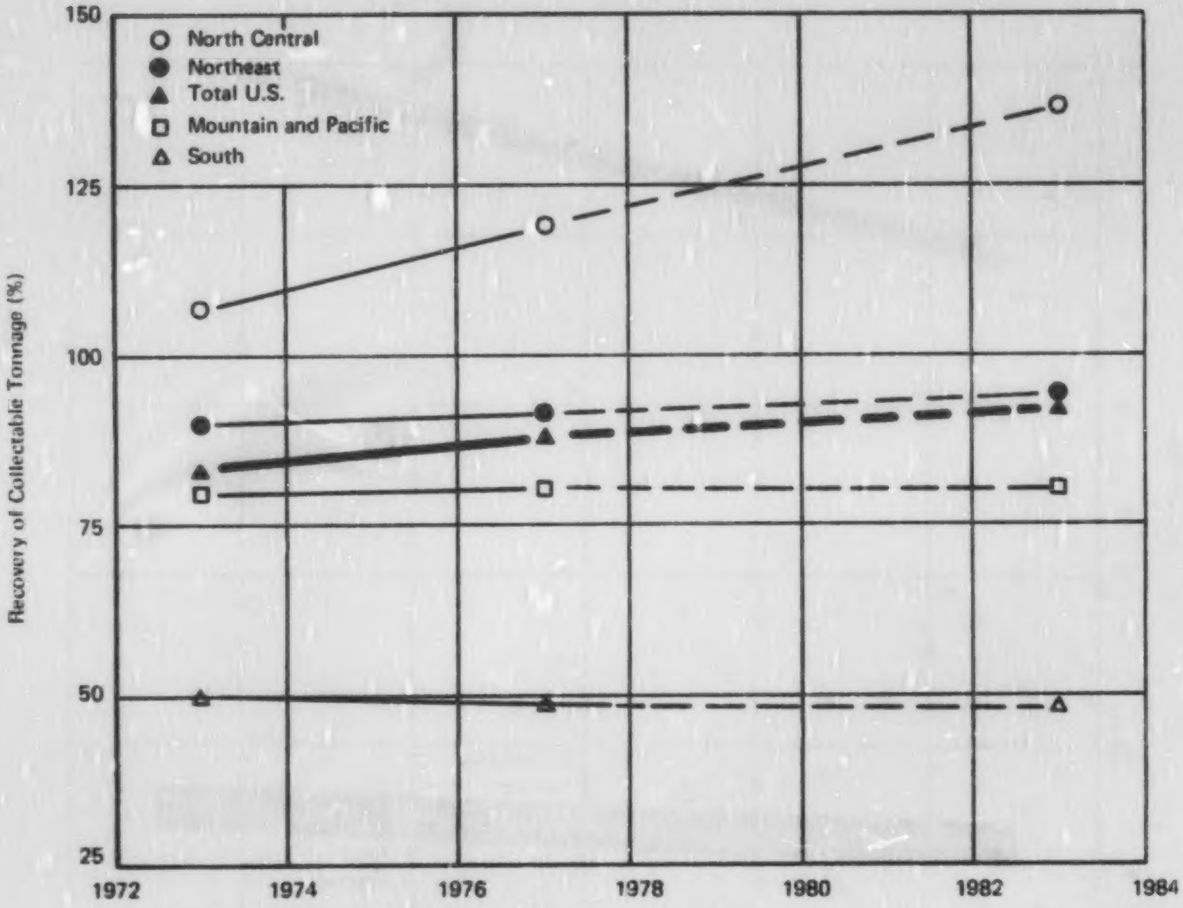
*Unlike the other bar charts in this section, apparent consumption of the original product is not shown. Only a small portion of the theoretical supply becomes P/S or deinking grade; most of it becomes mixed waste.



Sources: Tables VII–15, –16, and –17.

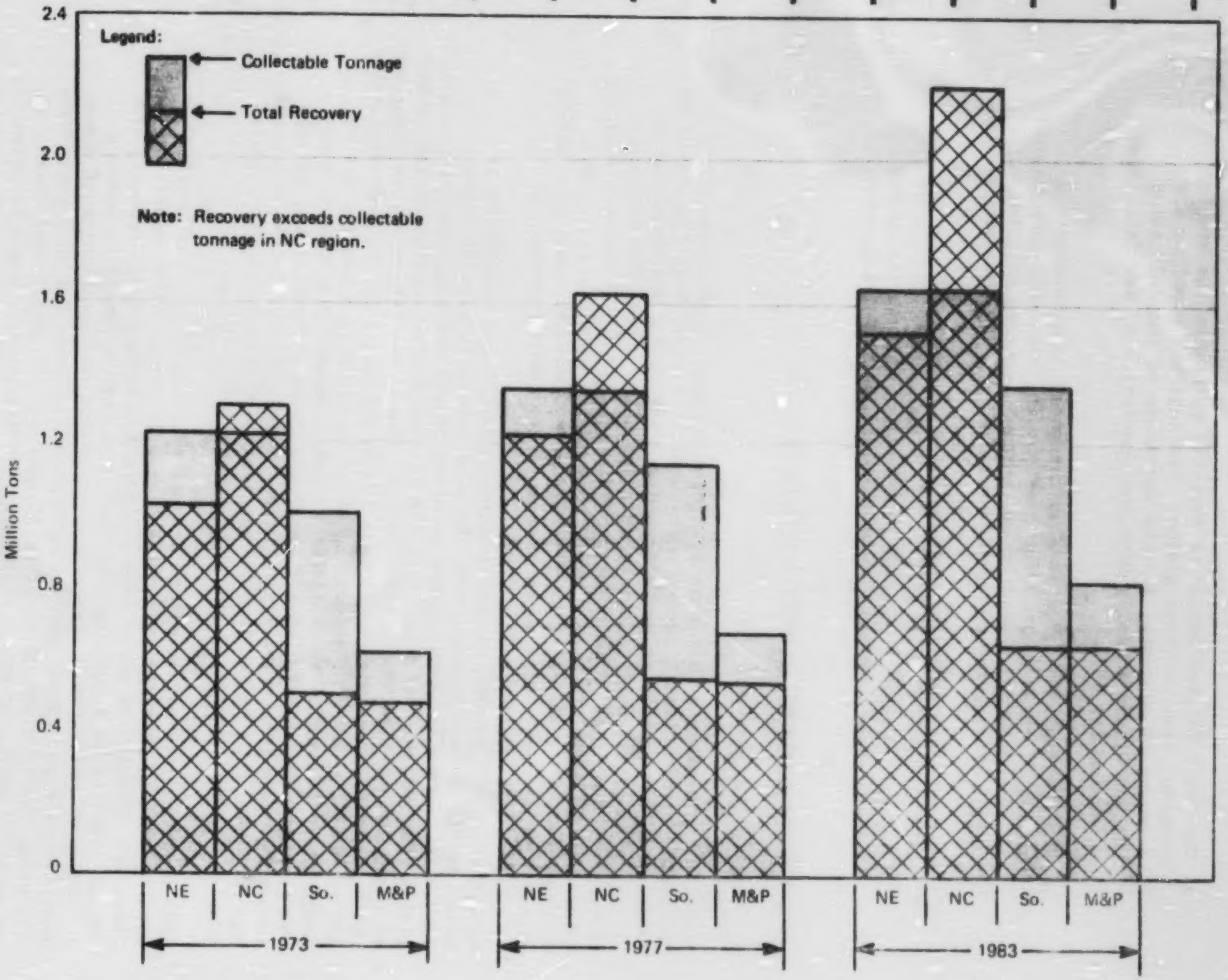
FIGURE VII–10 AVAILABILITY AND RECOVERY OF P/S AND DEINKING GRADES IN THE UNITED STATES



Basis: Assumes that the reuse of P/S and deinking grades will continue to increase at the same rate in 1977–1983 as it is projected to increase in 1973–1977.

Source: Tables VII-15, -16, and -17.

FIGURE VII–11 RECOVERY OF PULP SUBSTITUTES AND DEINKING GRADES BY MAJOR GEOGRAPHIC REGIONS, 1973–1983



Source: Tables VII-15, -16, and -17.

FIGURE VII–12 CONSUMPTION AND AVAILABILITY OF P/S AND DEINKING GRADES BY MAJOR GEOGRAPHIC REGION, 1973 TO 1983

- The North Central region is expected to remain the single greatest user of these grades. Its regional supplies are currently inadequate, and the magnitude of the deficiency will grow substantially with the completion of new facilities scheduled for 1977.

- The New England region is also currently deficient in its supply of these waste paper grades. It, too, will experience an increased deficiency as conventional sources fail to supply the additional tonnage required for 1977 recovery levels.

c. Related to the 1977-1983 Period

- New supply sources must be developed to sustain the growth rate projected for 1973-1977 through the 1977-1983 period.

E. COLLECTABLE TONNAGE OF MIXED WASTE PAPER

1. Bases of Evaluation

A wide variety of materials from all the functional groups contribute to the supply of mixed waste paper. As stated in Section V-C, the principal constituent (about 80%) is printing and writing paper; the remainder is largely a combination of containerboard and news. Thus, the potential theoretical supply of mixed paper from present sources (primarily office waste) can be gauged by the apparent consumption of the printing and writing grades. The total theoretical supply, however, could be expanded greatly by including waste paper discarded from other sources.

As a simplifying assumption in estimating the total availability of mixed waste, we have assumed that the same sub-categories of paper previously considered in deriving the quantity of P/S and high-quality deinking grades (see notes b and c to Table VII-14) would also constitute the source of mixed waste. From the total supply of these sub-categories, we deducted the amounts of scrap that would normally be discarded by the converter -- 15% of printing and writing and 12% of other converting papers; the remainder was assumed to be available as post-consumer discards of mixed waste paper. (Obviously, this figure is only an approximation, as some converter waste enters the mixed waste stream.) The collectable tonnage was broken down by region through application of the Population Concentration Factor.

This approach does not take into account the quantity of the original product that is retained as permanent records (e.g., bible paper) or that loses its identity as paper (e.g., decorative laminates). However, the amount involved in these applications is relatively small -- perhaps 1.4 million tons. Other assumptions regarding the composition of mixed waste and its geographic availability could be used, but they would not influence the findings of the overall analysis -- namely that there is an abundant supply of mixed waste and that its greater reuse is primarily limited by the low commercial utility of the resultant fiber. (See Section VIII)

2. Regional Supply/Demand Patterns

Table VII-18 summarizes the apparent consumption of the original product, the collectable tonnage, and the recovery of mixed waste paper in 1973. On a national basis, some 20.6 million tons, or 76% of the amount generated, is economically available for recovery (i.e., collectable tonnage), but only some 3.4 million tons presently is being utilized. All geographic regions have a substantial excess supply.

Tables VII-19 and -20 present the corresponding data for 1977 and 1983 respectively. On a national basis, the demand corresponding to announced new capacity is projected to increase slightly, but reuse will decline as a percentage of collectable tonnage.

Figure VII-13 summarizes and illustrates the relationship of apparent consumption to recovery on a national basis. The disparity between collectable tonnage and recovery of this paper stock grade is clearly shown.

Figure VII-14 illustrates the recovery rates for the major regions. It reveals that while the recovery of this grade will increase in the South, the other major regions show little growth or are actually declining.

Figure VII-15 is a graphic representation of the total theoretical supply, collectable tonnage, and apparent recovery. Tonnage figures are presented here rather than percentages to illustrate the magnitudes of the volumes in each region.

3. Summary of Analysis

a. Related to the 1973-1977 Period

- While there are slight regional differences in the rate of recovery, a substantial excess supply exists in each of the Bureau of Census regions;

b. Related to the 1977-1983 Period

- The supply of mixed waste will continue to grow faster than the expected demand. The increase in recovery rates will be limited by the technical utility of the fiber.

F. ALTERNATIVE METHOD FOR CALCULATING COLLECTABLE TONNAGE OF OCC

Since the original data on the collectable tonnage of OCC were prepared, we have developed a more direct and perhaps more accurate method for assessing the apparent consumption and hence the resultant collectable tonnage of this material. Although the net collectable tonnages estimated by this method are not significantly different from the earlier

(Cont'd on page VII-52)

TABLE VII-18

SUMMARY - CONSUMPTION AND AVAILABILITY OF MIXED PAPERS BY MAJOR GEOGRAPHIC REGION - 1973

Region	Apparent Consumption Of Original Products[1]	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage
	(000 tons)	(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U. S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	(000 tons)
New England	1,560	1,400	90	329	Neg	329	24	21	1,071
Middle Atlantic	6,220	5,500	88	700	Neg	700	13	11	4,800
NORTH EAST	7,780	6,900	89	1,029	Neg	1,029	15	13	5,871
East North Central	5,900	4,500	76	1,167	Neg	1,167	26	20	3,333
West North Central	2,180	1,200	55	117	Neg	117	10	5	1,083
NORTH CENTRAL	8,080	5,700	70	1,284	Neg	1,284	22	16	4,416
South Atlantic	3,490	2,500	72	419	Neg	419	17	12	2,081
East South Central	1,390	700	50	120	Neg	120	17	9	580
West South Central	2,100	1,500	71	270	Neg	270	18	13	1,230
SOUTH	6,980	4,700	67	809	Neg	809	17	12	3,891
Mountain	870	500	57	20	Neg	20	4	2	480
Pacific (Mainland)	3,120	2,700	86	231	Neg	231	8	7	2,469
Alaska & Hawaii	100	60	60	Neg	Neg	Neg	Neg	0	60
MOUNTAIN & PACIFIC	4,090	3,260	80	251	Neg	251	8	6	3,009
TOTAL U.S.	26,930	20,560	76	3,373	Neg	3,373	16	12	17,187

SOURCES:
1. Total - API "Statistics of Paper"; regional allocations - ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - U.S. Census Bureau data with ADL allocaton of total exports by major grade and point of debarkation (see Table V-4).

TABLE VII-19

SUMMARY - CONSUMPTION AND AVAILABILITY OF MIXED PAPERS BY MAJOR GEOGRAPHIC REGION - 1977

Region	Apparent[1] Consumption Of Original Products (000 tons)	Collectable Tonnage[2] (000 tons)	Collectable Tonnage[2] % of Apparent Consumption	Recovery of Waste Paper[3] Reused (000 tons)	Recovery of Waste Paper[3] Exported from U. S. (000 tons)	Recovery of Waste Paper[3] Total (000 tons)	Recovery of Waste Paper[3] % of Collectable Tonnage	Recovery of Waste Paper[3] % of Apparent Consumption	Net Collectable Tonnage (000 tons)
New England	1,730	1,500	90	331	Neg	331	22	19	1,169
Middle Atlantic	7,000	6,200	88	734	Neg	734	12	10	5,466
NORTH EAST	8,730	7,700	89	1,065	Neg	1,065	14	12	6,635
East North Central	6,600	5,000	76	1,246	Neg	1,246	25	19	3,754
West North Central	2,440	1,400	55	119	Neg	119	8	5	1,281
NORTH CENTRAL	9,040	6,400	70	1,365	Neg	1,365	21	15	5,035
South Atlantic	3,930	2,800	72	538	Neg	538	19	14	2,262
East South Central	1,560	800	50	132	Neg	132	16	8	668
West South Central	2,360	1,700	71	301	Neg	301	18	13	1,399
SOUTH	7,850	5,300	67	971	Neg	971	18	12	4,329
Mountain	960	600	57	30	Neg	30	5	3	570
Pacific (Mainland)	3,460	3,000	86	256	Neg	256	8	7	2,744
Alaska & Hawaii	100	60	60	Neg	Neg	Neg	Neg	0	60
MOUNTAIN & PACIFIC	4,520	3,660	80	286	Neg	286	8	6	3,374
TOTAL U.S.	30,140	23,060	76	3,687	Neg	3,687	16	12	19,373

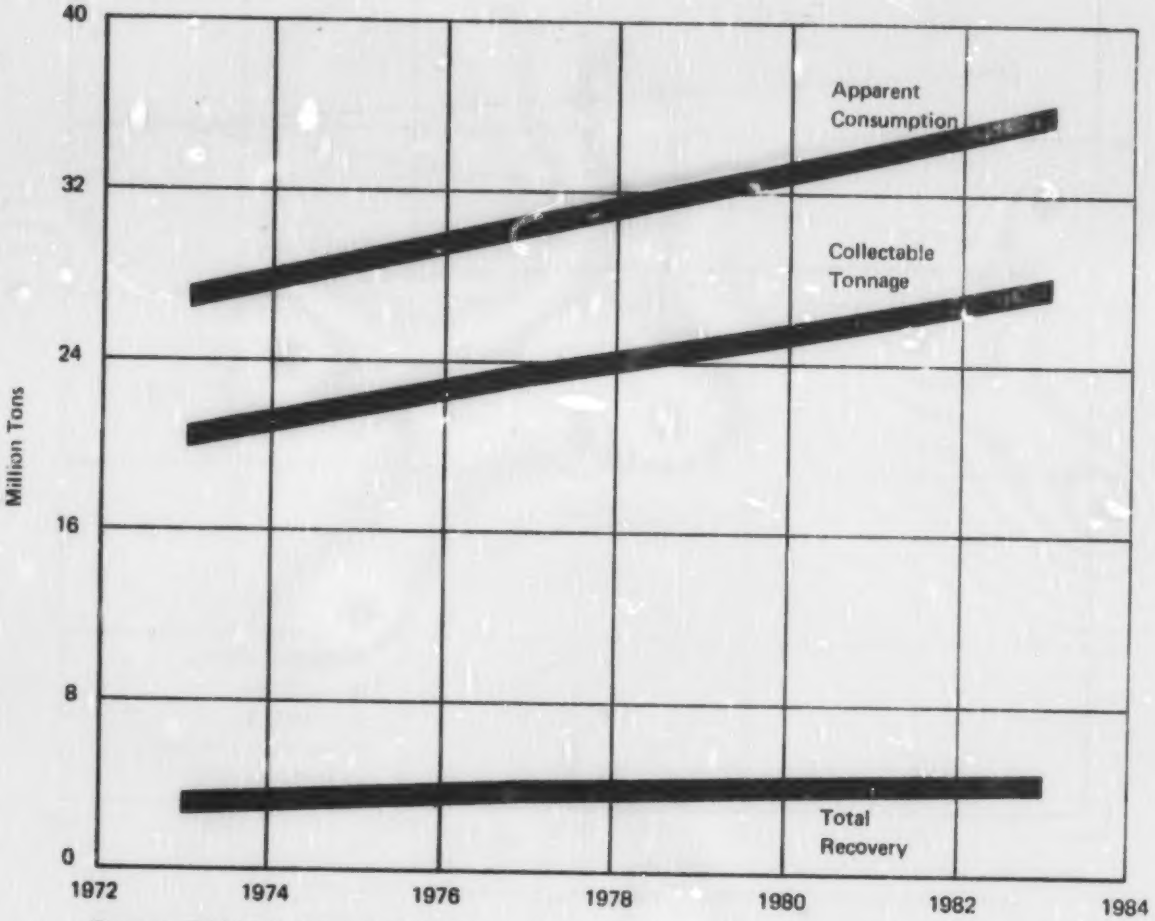
SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - extrapolated from 1973 figures at 8% per year.

TABLE VII-20

SUMMARY - CONSUMPTION AND AVAILABILITY OF MIXED PAPERS BY MAJOR GEOGRAPHIC REGION - 1983

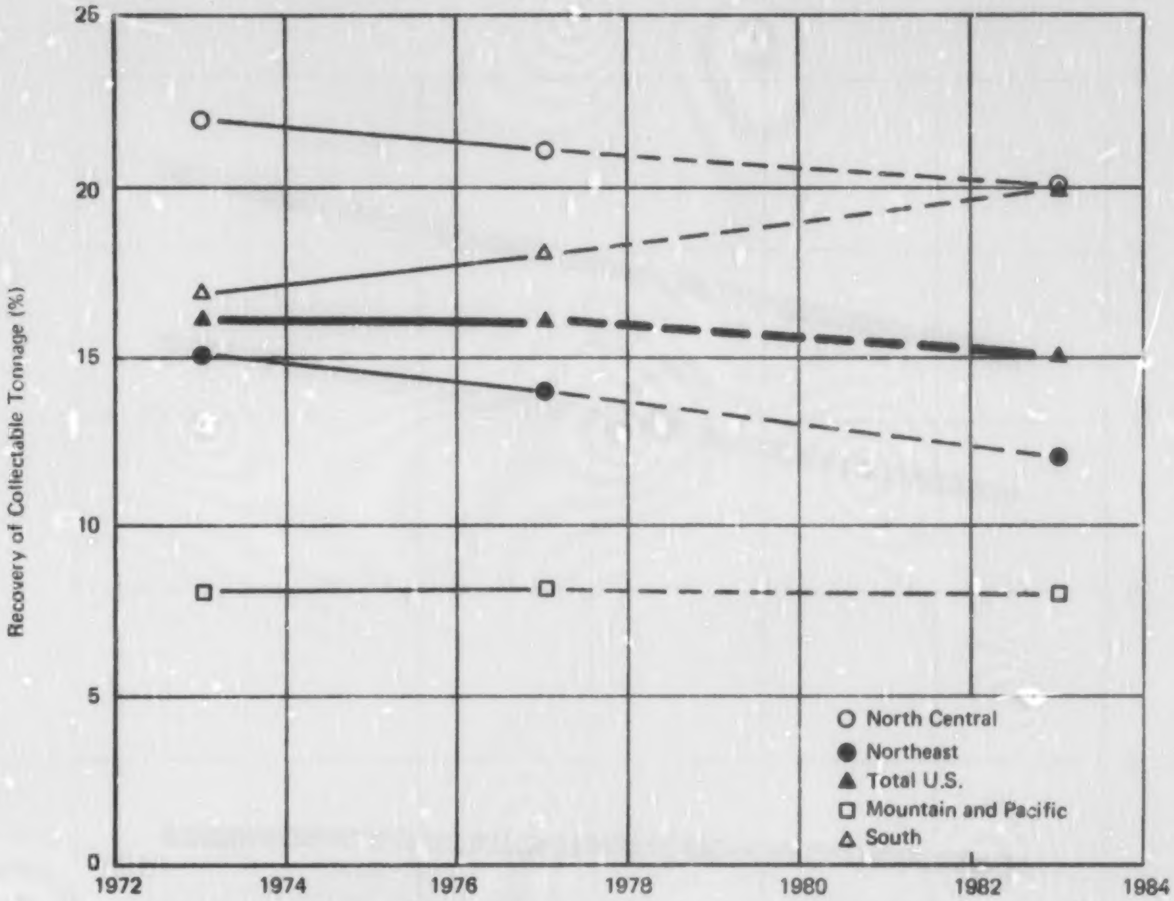
Region	Apparent Consumption Of Original Products[1] (000 tons)	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage (000 tons)
		(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U. S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	
New England	2,080	1,800	90	350	Neg	350	19	17	1,450
Middle Atlantic	8,390	7,400	88	780	Neg	780	10	9	6,620
NORTH EAST	10,470	9,200	89	1,130	Neg	1,130	12	11	8,070
East North Central	7,810	5,900	76	1,360	Neg	1,360	23	17	4,540
West North Central	2,870	1,700	55	130	Neg	130	8	4	1,570
NORTH CENTRAL	10,680	7,600	70	1,490	Neg	1,490	20	14	6,110
South Atlantic	4,720	3,400	72	710	Neg	710	21	15	2,690
East South Central	1,820	900	50	170	Neg	170	19	9	730
West South Central	2,800	2,000	71	400	Neg	400	20	14	1,600
SOUTH	9,340	6,300	67	1,280	Neg	1,280	20	14	5,020
Mountain	1,130	800	57	40	Neg	40	5	4	760
Pacific (Mainland)	4,160	3,600	86	300	Neg	300	8	7	3,300
Alaska & Hawaii	100	60	60	Neg	Neg	Neg	Neg	0	60
MOUNTAIN & PACIFIC	5,390	4,460	80	340	Neg	340	7	6	4,120
TOTAL U.S.	35,880	27,560	76	4,240	Neg	4,240	15	12	23,320

SOURCES: 1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - extrapolated by major geographic region at same rate as reported for 1973-77 period.
Exported - extrapolated from 1973 figures at 8% per year.



Sources: Tables VII–18, –19, and –20.

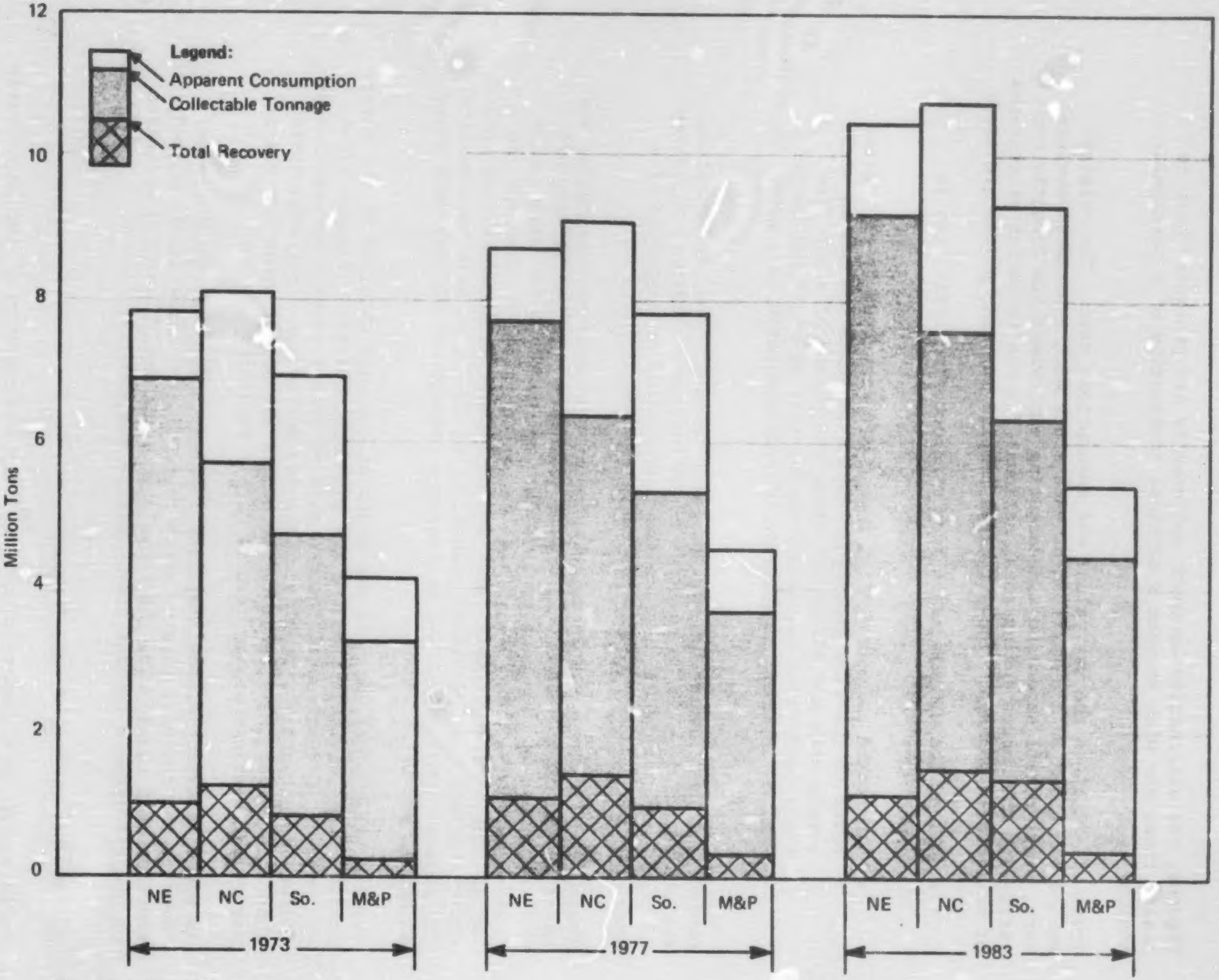
FIGURE VII–13 AVAILABILITY AND RECOVERY OF MIXED WASTE PAPER IN THE UNITED STATES



Basis: Assumes that the quantity of mixed waste recovered will continue to increase at the same rate in 1977–1983 as it is projected to increase in 1973–1977.

Source: Tables VII-18, -19, and 20.

FIGURE VII–14 RECOVERY OF MIXED WASTE BY MAJOR GEOGRAPHIC REGIONS, 1973–1983



Source: Tables VII-18, -19, and -20.

FIGURE VII–15 CONSUMPTION AND AVAILABILITY OF MIXED PAPER BY MAJOR GEOGRAPHIC REGION, 1973 TO 1983

figures, the alternative approach and results are presented here to assist those who wish to make a critical examination of a particular region.

Table VII-21 lists the key values and assumptions used. The original method was based on a comparison of each state with a national average; here, state retail sales and manufacturing employment are directly compared with the corresponding total national figures to derive percentages of collectable tonnage. Two principal simplifying assumptions are used:

- All of the OCC discarded from manufacturing activities is "collectable";
- Linerboard and corrugating medium are converted to corrugated boxes in the same geographic region in which the box is ultimately used and discarded; thus, the amount of scrap from these converting operations is directly proportional to the derived apparent consumption of containerboard in a given region.

Obviously, these assumptions do not apply to every case, and specific regional studies would be required to refine the preliminary estimates if they were to be used to guide the installation or expansion of a manufacturing facility based upon recycled fiber.

Table VII-22 shows a sample calculation of the apparent consumption and collectable tonnage of OCC in a selected state. Tables VII-23, -24 and -25 summarize the results of similar calculations for each census region. Appendix C-6 lists population concentration factors and the key indices of state retail sales and employment in manufacturing activities for all the individual states; using these, we have recalculated the apparent consumption and collectable tonnages of OCC for each state in Appendix C-7.

Figures VII-16, -17, and -18 are plots of the data obtained by the alternative method of estimation and are the counterparts of Figures VII-4, -5, and -6. Comparison of the two sets of graphs reveals no significant difference between the results of the two methods on a regional basis; thus, the use of the alternative method of estimation would not change any of our findings or the results of our analysis.

As would be expected, the disparity is greater for individual states. However, the regional figures are more pertinent, since it is unlikely that any mill considering the recycling of OCC would base its operation on the collectable tonnage from a single state.

G. SUMMARY OF COLLECTABLE TONNAGE

Table VII-26 is a summary of availability and recovery of the major waste paper grades by Census Bureau regions for 1977. The summary analysis is based upon the 1977 period, since usage patterns between 1973 and 1977

(Cont'd on page VII-62)

TABLE VII-21

ALTERNATIVE METHOD FOR DERIVING COLLECTABLE TONNAGE OF OCC

Base Year: 1973

NATIONAL DATA

	(000 tons)
Total National Consumption of Containerboard (TNC)	17,700
National Consumption, Manufacturing (NCM) = (TNC) x 57.8%*	10,230
National Consumption, Retail (NCR) = (TNC) x 42.2%*	7,470

STATE DATA

M_s = state manufacturing employees, percent of U.S. total

R_s = state retail sales, percent of U.S. total

PCF (Population concentration factor) = Percent of state population living in counties with population greater than 100,000

Pre-consumer (converter) waste = 10% of total containerboard consumption

Pre-consumer and manufacturing waste are 100% collectable; retail waste is collectable proportional to population concentration factor.

$$\text{Total State Consumption} = \text{Amount used in Manufacturing} + \text{Amount Used in Retail}$$

$$(TSC) = (NCM)(M_s) + (NCR)(R_s)$$

$$\text{Total State Collectable Tonnage} = \text{Pre-consumer Waste} + \overbrace{\text{Mfg. Sector} + \text{Retail Sector}}^{\text{Post-Consumer Waste}}$$

$$= (TSC)(.10) + (NCM)(M_s)(.90) + (NCR)(R_s)(.90)(PCF)$$

*See Table VII-6

TABLE VII-22

SAMPLE CALCULATION OF STATE CONSUMPTION AND COLLECTABLE TONNAGE OF OCC (ALTERNATIVE METHOD)

Sample State: Massachusetts

(000 tons)

$R_s = 2.81\%$

$M_s = 3.10\%$ } See Appendix C-6

$PCF = 96.3\%$

- Total State Consumption

$$(TSC) = (NCM)(M_s) + (NCR)(R_s)$$

$$= (10{,}230)(3.10\%) + (7470)(2.81\%)$$

$$317 + 210 = 527$$

- Total State Collectable Tonnage

$$= (TSC)(.10) + (NCM)(M_s)(.90) + (NCR)(R_s)(.90)(PCF)$$

$$(527)(.10) + (317)(.90) + (210)(.90)(96.3\%)$$

$$53 + 285 + 182 = 520$$

TABLE VII-23

CONSUMPTION AND AVAILABILITY OF OCC BY MAJOR GEOGRAPHIC REGION - 1973 (ALTERNATIVE CALCULATION)

Region	Apparent Consumption of Original Products[1] (000 tons)	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collect-able Tonnage (000 tons)
		(000 tons)	% of Apparent Consump-tion	Reused (000 tons)	Exported from U.S. (000 tons)	Total (000 tons)	% of Collect-able Tonnage	% of Apparent Consump-tion	
New England	1,164	1,073	92	334	30	364	34	31	709
Middle Atlantic	3,286	3,134	95	968	76	1,044	33	32	2,090
NORTHEAST	4,450	4,207	95	1,302	106	1,408	33	32	2,799
East North Central	4,102	3,772	92	1,738	45	1,783	47	43	1,989
West North Central	1,223	998	82	208	-	208	21	17	790
NORTH CENTRAL	5,325	4,770	90	1,946	45	1,991	42	37	2,779
South Atlantic	2,682	2,289	85	719	8	727	32	27	1,562
East South Central	1,128	934	83	302	-	302	32	27	632
West South Central	1,409	1,204	85	267	-	267	22	19	937
SOUTH	5,219	4,427	85	1,288	8	1,296	29	25	3,131
Mountain	573	448	78	30	None	30	6	5	418
Pacific (Mainland)	2,072	1,945	94	726	90	816	42	38	1,129
Alaska & Hawaii	62	48	77	Neg	None	Neg	0	-	48
MOUNTAIN & PACIFIC	2,707	2,441	90	756	90	846	35	31	1,595
TOTAL U.S.	17,700	15,845	90	5,292	250	5,542	35	31	10,303

SOURCES:
1. Total - API "Statistics of Paper"; regional allocations - ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
   Exported - U.S. Census Bureau data with ADL allocaton of total exports by major grade and point of debarkation (see Table V-4).

TABLE VII-24

CONSUMPTION AND AVAILABILITY OF OCC BY MAJOR GEOGRAPHIC REGION - 1977 (ALTERNATIVE CALCULATION)

Region	Apparent Consumption of Original Products[1] (000 tons)	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage (000 tons)
		(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U.S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	
New England	1,315	1,212	92	366	40	406	33	31	806
Middle Atlantic	3,713	3,541	95	1,179	100	1,279	36	34	2,262
NORTHEAST	5,028	4,753	95	1,545	140	1,685	35	34	3,068
East North Central	4,635	4,262	92	2,425	60	2,485	58	54	1,777
West North Central	1,381	1,128	82	237	-	237	21	17	891
NORTH CENTRAL	6,016	5,390	90	2,662	60	2,722	51	45	2,668
South Atlantic	3,031	2,586	85	1,257	10	1,267	50	42	1,319
East South Central	1,274	1,055	83	432	-	432	41	34	623
West South Central	1,592	1,360	85	416	-	416	31	26	944
SOUTH	5,897	5,001	85	2,105	10	2,115	42	36	2,886
Mountain	647	506	78	(30)	None	30	6	5	476
Pacific (Mainland)	2,341	2,198	94	(967)	120	1,087	49	46	1,111
Alaska & Hawaii	70	54	77	None	None	None	0	0	54
MOUNTAIN & PACIFIC	3,058	2,758	90	997	120	1,117	41	37	1,641
TOTAL U.S.	20,000	17,902	90	7,308	330	7,639	43	38	10,263

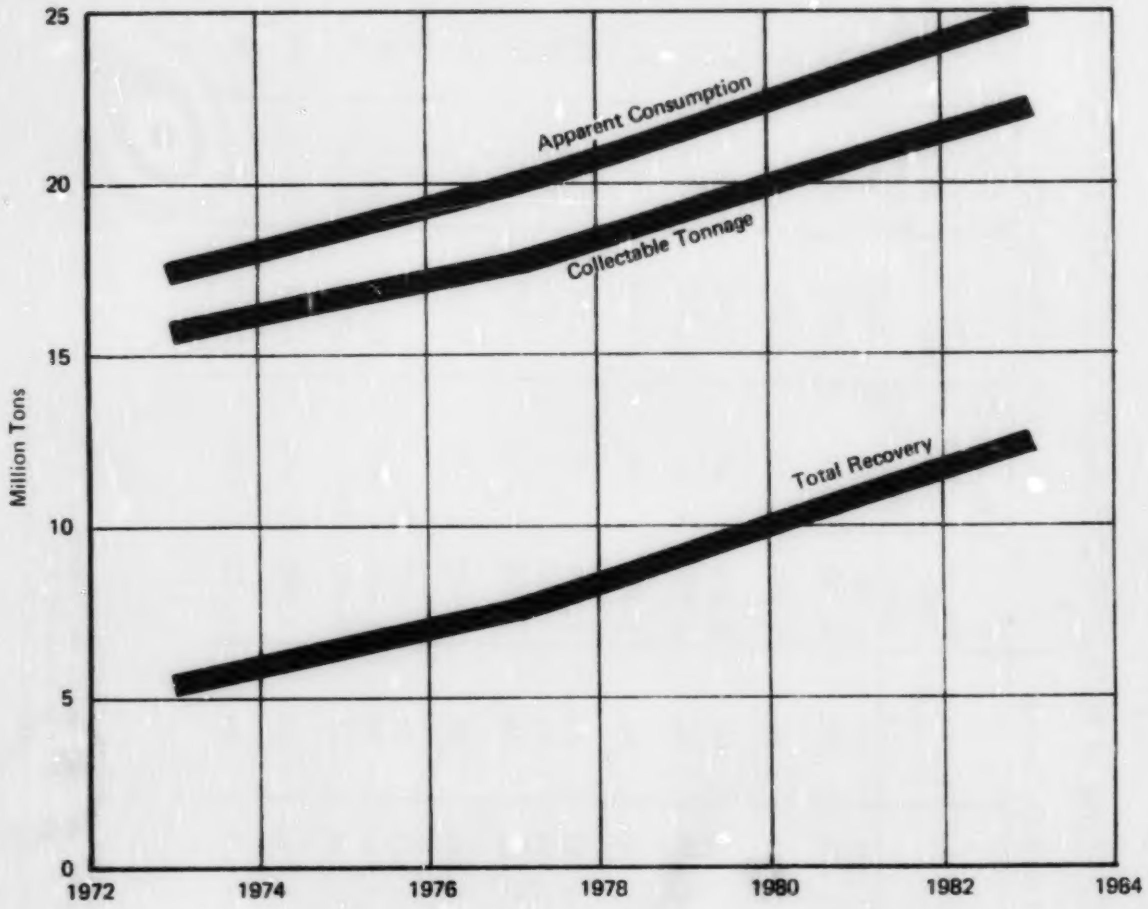
SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - API Capacity Survey data, pp. 21, 22
Exported - extrapolated from 1973 figures at 8% per year.

TABLE VII-25

CONSUMPTION AND AVAILABILITY OF OCC BY MAJOR GEOGRAPHIC REGION - 1983 (ALTERNATIVE CALCULATION)

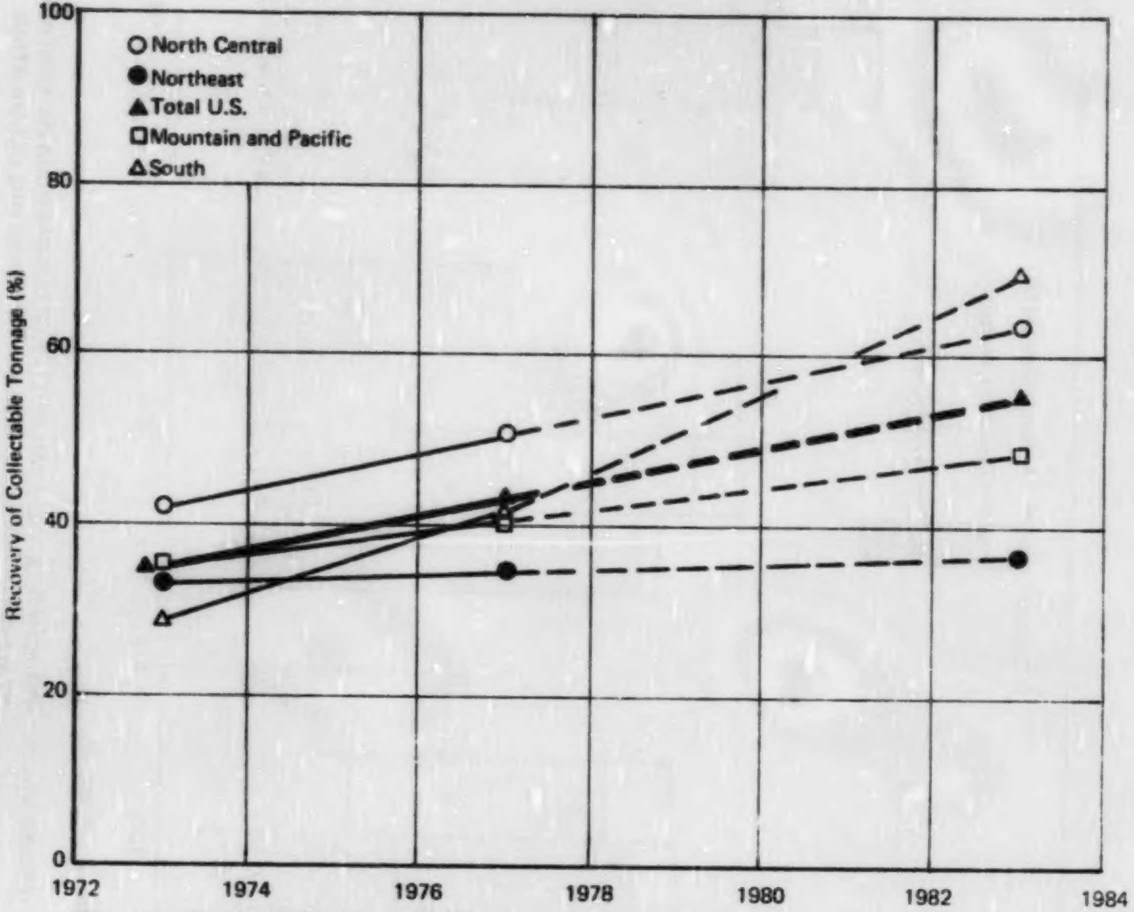
Region	Apparent Consumption of Original Products[1] (000 tons)	Collectable Tonnage[2]		Recovery of Waste Paper[3]					Net Collectable Tonnage (000 tons)
		(000 tons)	% of Apparent Consumption	Reused (000 tons)	Exported from U.S. (000 tons)	Total (000 tons)	% of Collectable Tonnage	% of Apparent Consumption	
New England	1,644	1,516	92	480	50	530	35	32	986
Middle Atlantic	4,641	4,426	95	1,540	130	1,670	38	36	2,756
NORTHEAST	6,285	5,942	95	2,020	180	2,200	37	35	3,742
East North Central	5,794	5,328	92	3,820	80	3,900	73	67	1,428
West North Central	1,727	1,410	82	400	-	400	28	23	1,010
NORTH CENTRAL	7,521	6,738	90	4,220	80	4,300	64	57	2,438
South Atlantic	3,788	3,233	85	2,590	10	2,600	80	69	633
East South Central	1,593	1,319	83	900	-	900	68	56	419
West South Central	1,990	1,700	85	900	-	900	53	45	800
SOUTH	7,371	6,252	85	4,390	10	4,400	70	60	1,852
Mountain	809	633	78	50	None	50	8	6	583
Pacific (Mainland)	2,927	2,747	94	1,490	160	1,650	60	56	1,097
Alaska & Hawaii	88	68	77	None	None	None	0	0	68
MOUNTAIN & PACIFIC	3,824	3,448	90	1,540	160	1,700	49	44	1,748
TOTAL U.S.	25,000	22,380	90	12,170	430	12,600	56	50	9,780

SOURCES:
1. ADL estimates.
2. ADL estimates (see supporting data for methodology).
3. Recovery of Waste Paper: Reused - extrapolated by major geographic region at same rate as reported for 1973-77 period.
Exported - extrapolated from 1973 figures at 8% per year.



Source: Tables VII-23, -24, and -25.

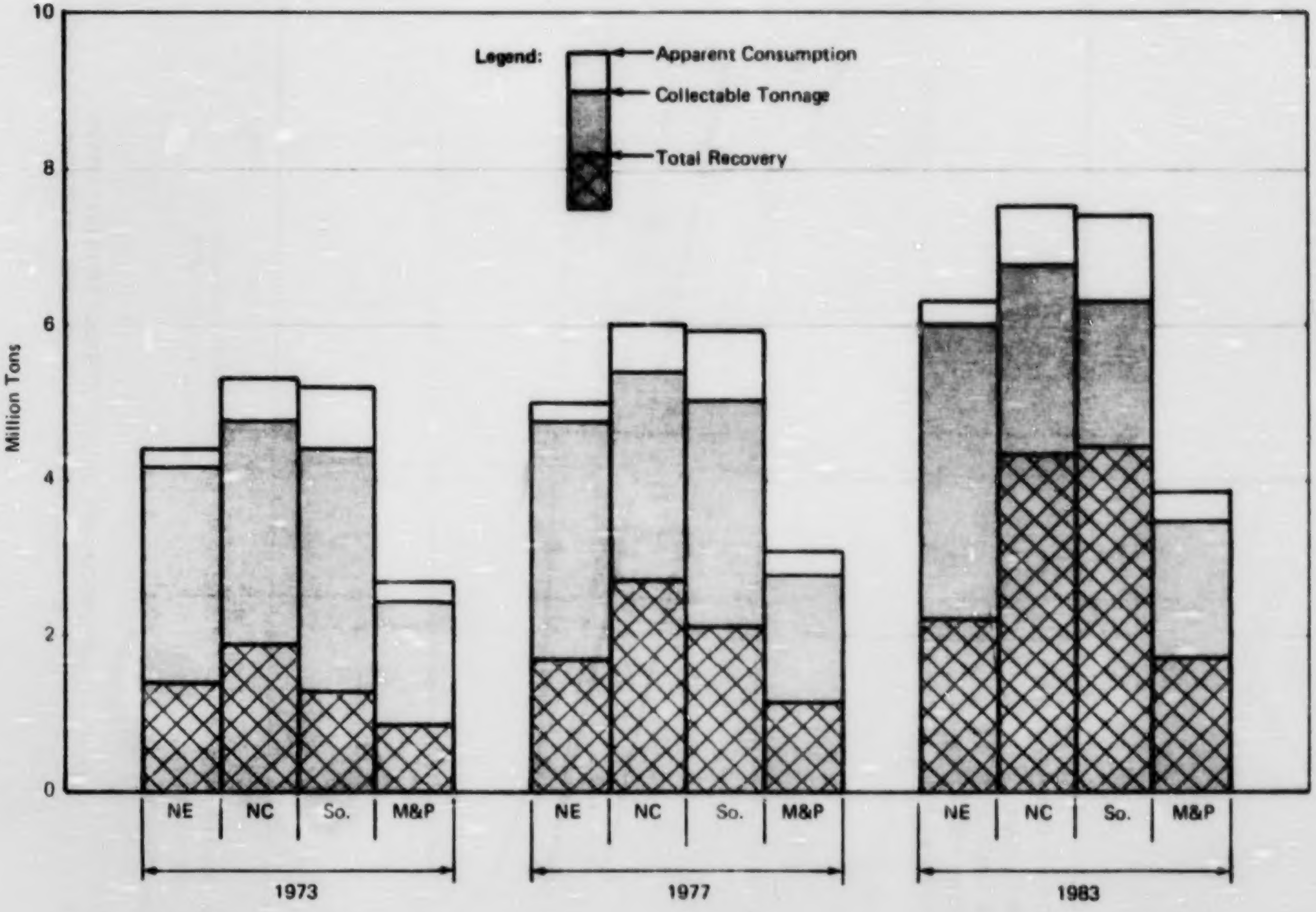
FIGURE VII–16 AVAILABILITY AND RECOVERY OF OLD CORRUGATED CONTAINERS IN THE UNITED STATES – ALTERNATIVE CALCULATION



Basis: Assumes that the quantity of OCC recovered will continue to increase at the same rate in 1977–1983 as it is projected to increase in 1973–1977.

Source: Tables VII–23, –24, and –25.

FIGURE VII–17 RECOVERY OF OLD CORRUGATED CONTAINERS BY MAJOR GEOGRAPHIC REGIONS – ALTERNATIVE CALCULATION



Source: Tables VII-23, -24, and -25.

FIGURE VII–18 CONSUMPTION AND AVAILABILITY OF OLD CORRUGATED CONTAINERS BY MAJOR GEOGRAPHIC REGIONS – ALTERNATIVE CALCULATION

TABLE VII-26

AVAILABILITY AND RECOVERY OF MAJOR WASTE PAPER GRADES IN 1977

	Apparent Consumption of Original Product(s) (000 Tons)	Collectable Tonnage		Projected Recovery			Net Collectable Tonnage (000 Tons)
		000 Tons	% of Apparent Consumption	Reused Plus Exported (000 Tons)	% of Apparent Consumption	% of Collectable Tonnage	
OCC							
North East	4,791	4,605	96	1,685	35	36	2,920
North Central	5,538	5,218	94	2,722	49	52	2,496
South	6,177	4,712	76	2,115	34	45	2,597
Mountain & Pacific	3,492	2,739	78	1,117	32	41	1,622
TOTAL U.S.	20,000	17,277	86	7,639	38	44	9,638
NEWS							
North East	3,100	2,720	88	1,118	36	41	1,602
North Central	3,074	2,200	72	883	29	40	1,317
South	3,342	2,314	69	480	14	21	1,834
Mountain & Pacific	2,193	1,795	82	603	28	34	1,192
TOTAL U.S.	11,700	9,029	77	3,084	26	34	5,945
P/S AND DEINKING							
North East	10,000	1,370	14	1,253	12	91	+ 117
North Central	10,400	1,360	13	1,613	16	119	- 253
South	9,000	1,150	13	551	6	48	+ 599
Mountain & Pacific	5,200	680	13	549	10	81	+ 131
TOTAL U.S.	34,700	4,560	13	3,966	11	87	+ 594
MIXED							
North East	8,730	7,700	89	1,065	12	14	6,635
North Central	9,040	6,400	70	1,365	15	21	5,035
South	7,850	5,300	67	971	12	18	4,329
Mountain & Pacific	4,520	3,660	80	286	6	8	3,374
TOTAL U.S.	30,140[a]	23,060	76	3,687	12	16	19,373
TOTAL U.S. Original Products	66,400	53,926	81	18,376	28	34	35,550

Source: 1. ADL estimates of apparent consumption and calculations of recovery
2. API Capacity Survey Data pertaining to Reused, + ADL estimates of Exported, of which OCC 330,000 tons, News 330,000 tons, P/S & Deinking 220,000 tons = Total 880,000 Tons.

[a] Not included in total

are projected to change. On the other hand, the projections are fairly reasonable, since the capacity to implement these changes has been installed or is committed.

Note that the analysis is based upon the recovery from the original products and that all products are not included since some remain in permanent records or lose their identity as paper. Hence, the apparent consumption of the original products is less than the projected 75.4 million tons of total U.S. paper and paperboard that will be consumed in 1977. Also note that both P/S-deinking and mixed waste come from the same original material. For the purposes of this analysis, we have assumed that only the portion discarded as converter waste becomes the P/S or deinking grade; the remainder is assumed to be potentially available as mixed waste.

The side-by-side analysis of the major waste paper categories facilitates their comparison. It reveals that by virtue of those factors which influence their respective usage and point of discard (hence their potential for recovery), OCC is by far the single largest category, both in actual tonnage and in percentage of apparent consumption. Some 17.3 million tons, or 86% of the apparent containerboard consumption, is estimated to be available for recovery (collectable tonnage). The projected recovery is estimated at 7.6 million tons, or about 44% of the collectable tonnage.

News is the second largest category, with a collectable tonnage of some 9.0 million tons, or 77% of the apparent consumption. As in the OCC category, the collectable tonnage expressed as a percentage of apparent consumption varies widely among (and, as previously illustrated, within) various regions. Recovery is projected to reach some 3.1 million tons, or about 34% of the collectable tonnage.

P/S and high-grade deinking are unique, in that the apparent consumption of the original products is the highest and the collectable tonnage is the lowest of the studied waste paper grades. Only some 4.6 million tons, or about 13% of the apparent consumption, is judged to be available from traditional recovery sources--i.e., printing and converting plants. New sources and new technology must be found to expand the supply of P/S and deinking; these grades are in great demand, as evidenced by their high rate of recovery.

For the purposes of this analysis, mixed waste is assumed to be derived from the same original products as the P/S and deinking grades; it has the largest potential supply--23 million tons, or about 76% of the apparent consumption. With a projected recovery of 3.7 million tons, it ranks higher than news (at 3.1 million tons) but it ranks lowest in the percentage of the original products recovered.

This entire analysis, it must be emphasized, is predicated on the economics of waste paper recovery, not necessarily its economical reuse in papermaking operations. Other factors previously described--industry characteristics and alternative wood supply--as well as others to be discussed under process economics, affect its competitive position. Thus, the 1983 tabulation of data does not constitute a projection of the likely reuse of waste paper in any studied region.

Since the recovery of waste paper is more traditionally expressed as a percentage of total apparent consumption of all grades rather than as a percentage of original products, the data in Table VII-26 have also been presented in this manner.

Table VII-27 presents the calculated regional distribution of all paper and paperboard grades based upon factors we used in postulating apparent consumption--namely state-by-state level of commercial and industrial activity (for OCC), actual consumption of newspaper (for news), and location of printing and converting facilities (for P/S and Mixed). The distribution (hence subsequently the regional recovery rates) derived in this manner is quite dissimilar to that derived simply from national per capita consumption. Table VII-28 uses this alternative method for deriving regional apparent consumption to illustrate the magnitude of the differences that result.

The recovery rates based upon our calculated regional consumption analysis are summarized in Table VII-29. The analysis supports the widely known fact that the North Central is by far the largest user of secondary fiber.

Further analysis shows the wide variance within the major geographic regions. Indeed, some regions (e.g., New England and the East North Central) have recovery rates comparable to some of the highest reported in the world. National averages thus tend to present a distorted view of the waste paper utilization pattern. It is appropriate to include the geographic and demographic characteristics in evaluating additional opportunities.

Table VII-29 also lists waste paper recovery as a percentage of fiber usage in each studied region. These data were derived from the capacity survey data reported by API, Figure VII-19. Note that of the 7.7 million tons of new capacity reported between 1973 and 1977, 3.2 million tons or fully 41% is for waste paper.

TABLE VII-27

APPARENT TOTAL CONSUMPTION OF PAPER AND PAPERBOARD BY REGION

	APPARENT CONSUMPTION (MM tons)		
	1973	1977	1983
New England	3.9	4.3	5.2
Middle Atlantic	12.8	14.5	17.3
Total Northeast	16.7	18.8	22.5
East North Central	13.6	15.3	18.3
West North Central	5.0	5.6	6.8
Total North Central	18.6	20.9	25.1
South Atlantic	10.1	11.3	13.7
East South Central	3.6	4.1	5.0
West South Central	6.1	6.9	8.2
Total South	19.8	22.3	26.9
Mountain	2.6	3.0	3.7
Pacific	8.8	9.9	12.0
Alaska & Hawaii	0.5	0.5	0.6
Total Mountain & Pacific	11.9	13.4	16.3
TOTAL U.S.	67.0	75.4	90.8

SOURCE: ADL estimates based upon published data from API for 1973 and ADL projections for 1977 and 1983.

TABLE VII-28

ESTIMATED REGIONAL CONSUMPTION OF PAPER AND PAPERBOARD BASED UPON POPULATION DISTRIBUTION

Basis: 1977 Projections

Region	Population Distribution (%)		Apparent Consumption (000 tons)	
New England	5.8		4,400	
Middle Atlantic	18.1		13,700	
Total Northeast		23.9		18,100
East North Central	19.6		14,800	
West North Central	8.0		6,000	
Total North Central		27.6		20,800
South Atlantic	15.3		11,500	
East South Central	6.3		4,800	
West South Central	9.6		7,200	
Total South		31.2		23,500
Mountain	4.2		3,200	
Pacific (Mainland)	12.5		9,400	
Alaska & Hawaii	0.5		400	
Total Mountain & Pacific		17.3		13,000
TOTAL U.S.		100		75,400

Source: ADL Estimates

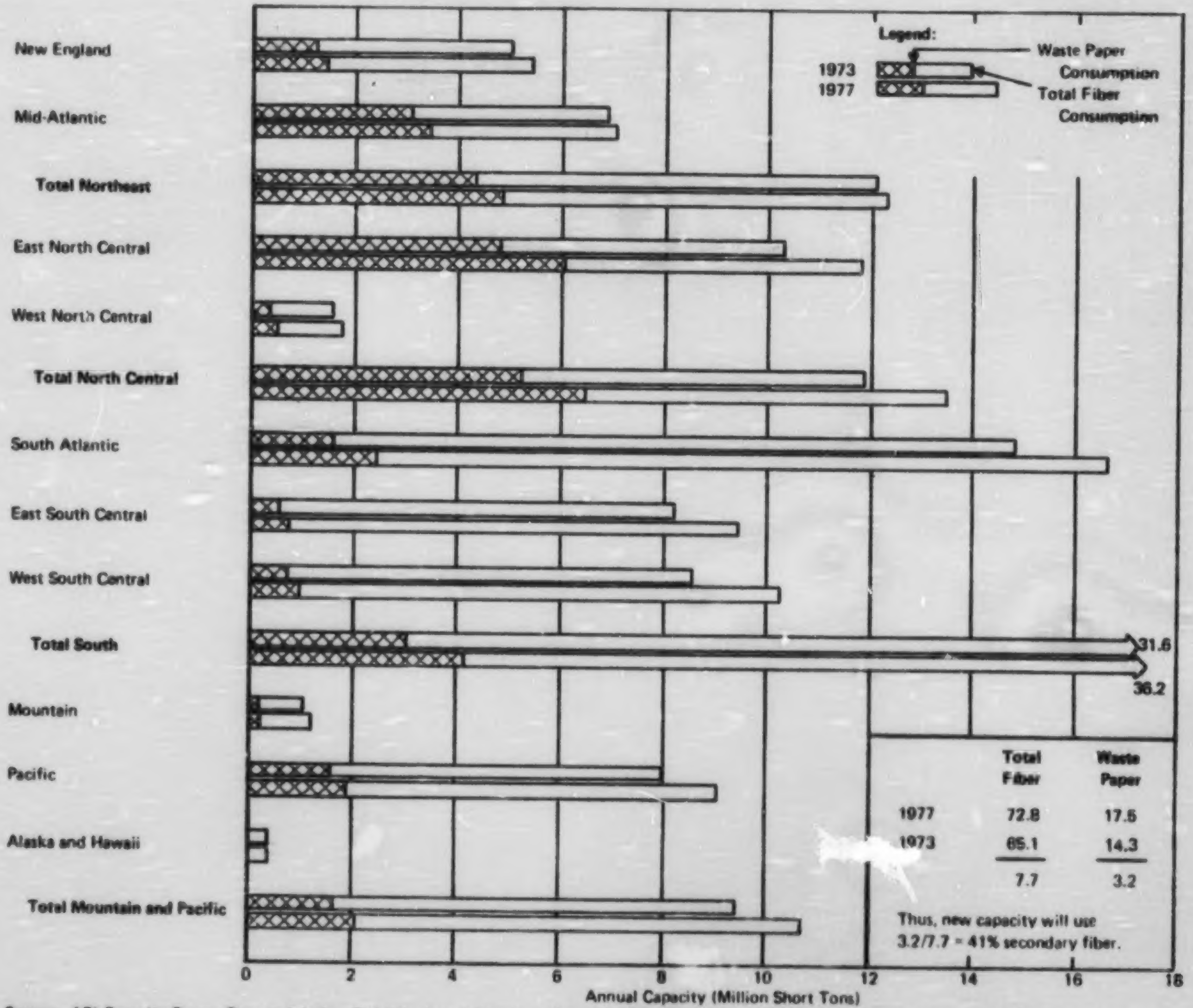
TABLE VII-29

ESTIMATED RECOVERY RATES FOR SECONDARY FIBER BASED UPON TOTAL APPARENT CONSUMPTION FOR 1977

	Total App. Consumption (000 tons)	Amount Recovered (000 tons)					Recovery Rates	
		OCC	News	PS & D/I	Mixed	Total	% of App. Consumption	Consumption Rate (%)[a]
New England	4,300	410	210	490	330	1,440	34	25
Middle Atlantic	14,500	1,300	910	760	730	3,700	26	50
Total Northeast	18,800	1,710	1,120	1,250	1,060	5,140	27	39
East North Central	15,300	2,480	820	1,560	1,250	6,110	40	51
West North Central	5,600	240	60	50	120	470	8	27
Total North Central	20,900	2,720	880	1,610	1,370	6,580	32	48
South Atlantic	11,300	1,270	280	290	540	2,380	21	14
East South Central	4,100	430	100	100	130	760	19	8
West South Central	6,900	420	100	150	300	970	14	9
Total South	22,300	2,120	480	540	970	4,110	18	11
Mountain	3,000	30	40	30	30	130	4	} 20
Pacific	9,900	1,090	560	520	260	2,430	24	
Alaska & Hawaii	500	-	-	-	-	-	0	0
Total Mountain & Pacific	13,400	1,120	600	550	290	2,560	19	20
TOTAL U.S.	75,400	7,700	3,100	4,000	3,700	18,400	24	24

Source: Based upon published data for domestic consumption of S/F and ADL estimates of exports and total apparent consumption of paper and paperboard for 1977.

[a] Ratio of domestic S/F usage to regional papermaking capacity.



Source: API Capacity Survey Data and Arthur D. Little, Inc. (allocation of capacity for sub regions in the reported Mountain and Pacific Region).

FIGURE VII-19 COMPARISON OF WASTE PAPER USAGE TO TOTAL FIBER CONSUMPTION, 1973/1977

VIII. SUBSTITUTABILITY OF SECONDARY FIBER

This section seals with the suitability of secondary fiber as a substitute for virgin fiber in the manufacture of selected paper and paperboard products. The analysis is made on the basis of technical adequacy only; the economic feasibility of using S/F as either a complete replacement or a fiber supplement is discussed separately. Information used in this analysis was obtained from both published and unpublished sources and interviews with selected manufacturers.

A. APPROACH

The feasibility of substituting virgin fiber with secondary fiber is not a precise technical evaluation. The quality of the recovered secondary fiber is influenced by (1) the characteristics of the original product, (2) the history of the recovered waste paper, and (3) the ability of the reprocessor to recover maximum utility (cleanliness and strength) of the secondary fiber.* Furthermore, the properties of the virgin fiber products are also subject to variation from alternative pulping processes, choice and blend of wood species, and other process variables.

Therefore, we shall present a discussion of the typical usage of virgin and recycled fiber that illustrates the range of variability within and between similar virgin and S/F products. Subsequently, we discuss the applicability of S/F to specific grades of products within each functional group selected for economic analysis.

B. HISTORICAL USAGE PATTERNS

Descriptive information on each of the major wood pulping process is given in Table VIII-1. In chemical pulp (either kraft or sulfite), long-fibered softwood species (the conifers) are generally used where tear, burst, and tensile strength are desired; the shorter-fibered (deciduous) species are used where opacity, printability, and sheet formation are desired. In high-yield (mechanical) pulp, the softwood species are generally preferred, because the wood fibers are long enough to survive the mechanical attrition and yield suitable fiber.

The table also lists typical values of pulpwood yields to permit rough comparisons. More detailed information on yields is given in Section IX, Process Economics.

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* J.H. Klungness, "Recycled Fiber Properties as Affected by Contaminants and Removal Process", TAPPI, Vol. 57, No. 11, Nov. 1974

TABLE VIII-1

COMMERCIAL PROCESSES FOR PULPING WOOD

Pulp Classification	Name of Process	Process Description	Woods Used	Yield[a] of Pulp by Weight, bl/unbl (%)	Strength of Pulp [b]	How Pulp is Used	Final Product	U.S. Production 1973 [a,c] (000 tons)	Minimum mill capacity[a] (tpd)	Cost of Pulpmill[a] ($000/tpd)	Number of pulp-mills[a] in U.S. 1973
Chemical	Kraft	Woodchips reduced under steam pressure to pulp with alkaline chemicals (sodium hydroxide and sodium sulfide).	Softwoods Hardwoods	42/49 44/49	Softwoods high to very high, hardwoods medium to medium high	Higher yield pulp used for container board. Lower yield pulp used for numerous grades of paper. Often mixed with other pulps.	Strong wrapping and bag paper Container board Book Newsprint Highest grade magazine and other printing papers Bond Writing	32,443[d,e]	Bleachable grade, 600 Kraft grade, 400	100-180	114
	Sulfite	Woodchips reduced under steam pressure to pulp with an acid chemical (calcium, magnesium, sodium, or ammonium bisulfite plus sulfurous acid)	Softwoods: Spruce Balsam Hemlock Southern pine Hardwoods: Eastern and Lake States	44/49 44/49	Softwoods, medium high Hardwoods, medium low	Usually mixed with other pulps. When purified, used for cellulose products.	Book and magazine Wrapping Bond Tissue Newsprint Glassine Writing Cellulose derivatives	2,300[d]	400	150-180	28
	Soda	Woodchips reduced under steam pressure to pulp with an alkaline chemical (caustic soda).	Mostly Hardwoods: Aspen Cottonwood Basswood Beech Birch Maple Tupelo (gum) Oak	40/48	Medium to medium low	Often mixed with sulfite and other pulps	Book and magazine Lithograph Other printing papers Envelope Blotting paper	136	-	-	3
Semichemical	Neutral sulfite, bisulfite, acid sulfite, kraft	Woodchips partially softened under steam pressure with chemicals are reduced to pulp by mechanical action.	Hardwoods: Same as for soda pulp Red Alder Often pulped in mixtures Softwoods: Small amounts of Douglas fir, Ponderosa pine and sugar pine	-/60-80 60/80	Medium to medium low	Alone in corrugating and some other boards. Bleached pulps mixed with softwood pulps for other products.	Corrugating board Food and other specialty boards Glassine Magazine Newsprint Insulating and sheathing board	3,868	300[f]	80-100	40
Dissolving	Kraft or Sulfite	Woodchips reduced under steam pressure to pulp with acid or alkaline chemicals	Softwoods: Spruce Hemlock Southern Pine	30-35	Low	Pre-hydrolysis sulfate pulp used for rayon	Rayon	1,672	600	200	10

Sheet 1

TABLE VIII-1 (Cont'd)

COMMERCIAL PROCESSES FOR PULPING WOOD

Pulp Classification	Name of Process	Process, Description	Woods Used	Yield[d] of Pulp by Weight, bl/unbl (%)	Strength of Pulp[b]	How Pulp is Used	Final Product	U.S. Production 1973 [a,c] (000 tons)	Minimum mill capacity[a] (tpd)	Cost of Pulpmill[a] ($000/tpd)	Number of pulpmills in U.S. 1973
Chemimechanical	Mason (exploded) Asplund (defiberated)	Woodchips treated with steam or hot water at high temperatures and pressures to soften the wood, followed by mechanical fiberization.	Softwoods and hardwoods	-/80-95	Low to very low	Coarse pulps composed of a mixture of single fibers and fiber bundles used alone and mixed with wastepaper and other pulps	Hardboard Insulating board Roofing and linoleum felts	2,930	50	60-80	61
	Cold soda	Woodchips given mild treatments with sodium hydroxide solutions and then mechanically fiberized to pulp	Hardwoods: Birch Maple Beech Oak Sweetgum Aspen Often pulped in mixtures	80/95	Medium low to low	Often mixed with other pulps	Corrugating board Boxboard and molded products Book paper and newsprint	100	-	-	3
	Hot Sulfite	Woodchips given mild treatments with sodium sulfite solutions and then mechanically fiberized to pulp.	Softwoods: Balsam Fir Hemlock Spruce Hardwoods: Birch Aspen and others	80/95	Medium to medium low	Mixed with groundwood and sulfite pulps	Book paper	70	50	60-80	4
Mechanical	Groundwood	Wood bolts reduced to pulp by pressing on a revolving grindstone, or chips mechanically fiberized to pulp.	Softwoods: Spruce Balsam Pine Hemlock Hardwoods: Aspen Cottonwood	93/93 93/93	Low Low	Usually mixed with chemical pulp	Newsprint Magazine-book Catalog Tissues Toweling Carton board Container board Building board Insulating board	4,813	100	50-80	65

[a] ADL estimates

[b] A very general rating based on the full range of pulp strengths. Good strength in a pulp is desirable though not necessarily essential to its usefulness. Between two pulps otherwise comparable, the one with the better strength would be preferred.

[c] Except for kraft and sulfite, nearly every kind of pulpmill must be integrated with a paper or board mill, with excess production being offered for sale. Purified pulpmills and some large kraft mills produce pulp for market only. One or two small groundwood pulpmills produce market pulp only, but sales are limited to the local area.

[d] Does not include rayon and cellulose derivative grades.

[e] Does not include kraft semichemical.

[f] Recovery of spent sodium sulfite liquors now under commercial development. Minimum size of these new recovery plants not known; probably not less than 100 tpd of pulp. If semichemical pulp plants are integrated with kraft mills, their spent liquors can be processed in the kraft chemical recovery plant. Probably no limitation on the size of a kraft semichemical pulp plant if so integrated. A neutral sulfite semichemical pulp plant would be limited to a size equivalent to about 1/3 the liquor recovery capacity of the kraft mill. In either case, the integrated recovery system must have sufficient capacity to process the combined spent liquors from both plants.

Source: Forest Products Laboratory Publication 66-028, Forest Service, U.S. Department of Agriculture, 1966 (updated by Arthur D. Little, Inc.)

In practice, interactions among wood properties, pulping conditions, and end-use requirements of the resulting pulp influence the yield that is actually achieved by any given mill. The Forest Products Laboratory of Madison, Wisconsin, has compiled data on wood density and pulp yield for U.S. pulpwoods.* In the eleven years since its report was issued, some of the yields have been improved, but only slightly. Thus, the FPL data are still useful for estimating purposes, in the absence of more recent information.

Table VIII-1 illustrates the many pulping processes and wood species that can be used in the manufacture of virgin fiber products. Implicit in these choices is the fact that even virgin fiber products are subject to quality variations.

Table VIII-2 lists the amounts of S/F used in the manufacture of paper and paperboard. (Data for 1969 are used because they are the most recent available in this detailed format; more recent data are aggregated in much larger categories.) The table shows the relative importance of S/F in key product areas, specifically corrugating medium, tissue, combination folding boxboard, and construction (builder's) paper and board. The potential opportunity to increase S/F usage in each functional group is discussed in the remainder of this section.

Mill survey data identifying the quantity of S/F used in the manufacture of selected products is contained in Appendix C-4. The wide variation of S/F used in the manufacture of even similar products supports the initial statement: namely, that the substitutability of virgin with secondary fiber is not (in our opinion) subject to precise technical evaluation. Site and process conditions, which cannot be specified in this generalized assessment, influence the quality of the recycled and virgin fiber products. Nevertheless, the reported mill data and this analysis provide the framework and insight to make a more detailed analysis using more specific site, process, and product conditions.

C. CONTAINERBOARD

Two distinctly different products--linerboard and corrugating medium--are included in this functional group. Each offers unique potential opportunities for the use of secondary fiber. At present, S/F is used as either a complete replacement or a partial substitution for virgin fiber in both products.

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*"Pulp Yields for Various Processes and Wood Species," Forest Products Laboratory, February 1964.

TABLE VIII-2

PAPER AND PAPERBOARD PRODUCTION AND WASTE PAPER CONSUMPTION - 1969

Functional Group and Grade	Production(1) (000 tons)	WASTE PAPER CONSUMPTION(2) (000 tons)	% of Prod.	% of Total Waste Paper
CONTAINERBOARD				
Linerboard (virgin)	11,157	200	1.8	1.7
Linerboard (combination)	402	436	108.0	3.6
Total Linerboard	11,559	636	5.5	5.3
Corrugating Medium (NSSC)	3,547	672	18.9	5.6
Corrugating Medium (Comb.)	939	663	70.6	5.5
Total Medium	4,486	1,335	29.8	11.2
Container Chipboard	283	300	106.0	2.5
TOTAL CONTAINERBOARD	16,328	2,271	13.9	19.0
GROUNDWOOD PAPERS				
Newsprint	3,253	372	11.4	3.1
Printing Papers	1,208	100	8.3	0.8
TOTAL GROUNDWOOD	4,461	472	10.6	3.9
TISSUE AND OTHER MACHINE CREPED PAPERS	3,575	962	26.9	8.0
FOLDING BOXBOARD				
Combination	2,852	3,280	115.0	27.4
Unbleached	322	59	3.4	0.5
Bleached (SBS)	1,434			
Milk and Food Service	1,574	16	1.0	0.1
Non-bending and other combination	1,164	1,383	119.0	11.6
TOTAL FOLDING BOXBOARD	7,346	4,738	64.5	39.6

(Cont'd next page)

TABLE VIII-2 (Cont'd)

PAPER AND PAPERBOARD PRODUCTION AND WASTE PAPER CONSUMPTION - 1969

Functional Group and Grade	Production(1) (000 tons)	WASTE PAPER CONSUMPTION(2) (000 tons)	% of Prod.	% of Total Waste Paper
PRINTING, WRITING, AND RELATED (Excl. Groundwood printing)	10,038	378	3.8	3.2
INDUSTRIAL PACKAGING, CONVERTING & MISC.				
Packaging & Converting	5,078	131	2.6	1.1
Special Industrial	443	34	7.7	0.3
Tube, Can, Drum (virgin)	207	0	0	0
Tube, Can, Drum (comb.)	527	646	122.0	5.4
Molded Pulp Products (incl. fiber pipe)	?	179	?	1.5
Other Paperboard	815	25	3.1	0.2
TOTAL INDUSTRIAL	7,070	1,015	14.4	8.5
CONSTRUCTION PAPER AND PAPERBOARD				
Gypsum Linerboard	847	903	107.0	7.5
Construction Paper	1,603	1,134	70.7	9.5
Insulation & Hardboard	2,773	0	0	0
Wet Machine Board[a]	148	96	64.9	0.8
TOTAL CONSTRUCTION	5,371	2,135	39.8	17.8
TOTAL PAPER AND PAPERBOARD	54,189	11,969	22.1	100.0

a. Not included in the analysis of this functional group

SOURCE: (1) 1969 Historical Data: Bureau of Census, "Pulp, Paper and Board", Series M26A (70-13) for production.
(2) W. S. McClenehan, "Consumption of Paper Stock by U.S. Mills in 1969 and 1970."

1. Linerboard

High burst, tensile, and tear strength are the major product requirements of linerboard. To achieve these properties, softwood pulped via the kraft process is used in its manufacture. Up to 20% of hardwood is typically added, primarily to obtain smoothness and printability. The hardwood furnish is applied via a secondary headbox on a conventional Fourdrinier board machine. A pulpwood yield of 52-54% is typical for the filler liner; somewhat lower yields (50%) are more typical for the top liner.

Linerboard is characterized by a high degree of product standardization. Interstate freight regulation Rule 41 specifies the burst strength and basis weight of this product. In general, the ratio of burst strength to weight for recycled linerboard--so called "jute liner" is inferior to that of virgin kraft liner. To obtain the necessary strength, the jute liner has three alternatives:

(a) Increase the degree of refining of the waste paper furnish;

(b) "Give away" basis weight--e.g., provide 45-47 pound per 1000 sq ft (lb/MSF) as a replacement for 42 lb/MSF virgin liner, in effect discounting the price on a weight basis by 10-15%;

(c) Add dry-strength chemicals to achieve comparable strength at the same basis weight as that obtained for virgin kraft;

Choice (a) is seldom exercised, since the excessive refining slows drainage on the machine, thus ultimately reducing machine production. The choice between (b) and (c) depends on the economics of the situation, including the prevailing cost of waste paper; thus, the decision may change with shifting economic patterns.

Old corrugated boxes, with butt rolls of virgin liner or double-lined kraft cuttings occasionally included, are the typical fiber furnish for the manufacture of jute linerboard. The presence of the short fiber in the corrugating medium plus the simple loss in bonding strength intrinsic with reworked fiber cause the reduced tear, tensile, and bond strength that are characteristic of jute liner.

In order to remove one of the factors contributing to the deterioration of strength, a number of processes have been developed to separate the softwood kraft fibers in the liner fraction from the hardwood fibers in the medium fraction. The use of fiber separation techniques is reported to impart superior burst and tensile strength in the liner fraction at higher freeness values.*

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*L.E. Clark and F.D. Iannazzi, "Fiber Separation as a Means of Increasing Utilization of Waste Corrugated Boxes," TAPPI, Vol. 57, No. 11, November 1974.

In addition to complete replacement of virgin with S/F, as practiced by nonintegrated mills making jute liner, many integrated mills are blending OCC with virgin fiber in the manufacture of kraft linerboard. Reportedly, 20-25% OCC may be incorporated with virgin fiber with no significant deterioration of strength qualities or runability on the paper machine.* It is assumed that the hardwood content is reduced as the S/F content increases.

2. Corrugating Medium

Linerboard is combined with fluted medium to produce combined board or corrugated containerboard; the liner provides the tensile and tear strength, while the medium provides rigidity for crush resistance. For this reason, the medium is generally manufactured from hardwoods and almost exclusively by the NSSC process to provide high yield and maximum retention of the high-bonding-strength hemicelluloses. Pulp yields of 72-75% are typical for this grade.

To improve the "runability" of the fiber furnish in the paper machine, 10-20% kraft fiber is generally added to the NSSC pulp. Typically, the kraft fiber is obtained by repulping new double-lined kraft clippings from corrugated box plants. Clippings are the preferred material in this application because their quality and cleanliness are assured.

Beyond the typical 10-20% S/F included to improve runability of the fiber furnish on the board machine, corrugating medium is also made from various ratios of fiber blends ranging up to complete replacement of virgin fiber.

The cost of new double-lined kraft clippings generally is higher than that of producing virgin NSSC pulp; hence, clippings are used principally to improve runability on the board machine. OCC is typically the preferred source of S/F as a complete replacement or partial substitute for NSSC fiber, but some firms reportedly add news or mixed waste paper (see Appendix C-4) to the fiber furnish. In our analysis, we assumed that OCC was the source of replacement fiber for NSSC pulp.

Historically, there has been considerable controversy about the relative strength qualities of virgin and recycled (bogus) medium. Contacts we have made in the performance of this study and information reported in the published literature** indicate that comparable properties can be achieved with either material. The choice of the fibrous raw material and the pulping and papermaking conditions have a greater effect on the product than the choice of virgin or recycled fiber. In this study, the quality obtained from fiber blends or complete replacement of NSSC pulp is assumed to be comparable to that of virgin semichemical medium.

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* G.T. Edmonds, "Economics of Recycle Usage," TAPPI, Vol. 57, No. 12, December 1974.

** "Paper Recycling — The Art of the Possible, 1970-1985," report to the Solid Waste Council of the Paper Industry, Midwest Research Institute, 1973, p. 90.

D. GROUNDWOOD PAPER

There are three principal grades of groundwood paper, each with its own product requirements and opportunity to utilize secondary fiber -- namely. groundwood printing, newsprint, and groundwood specialties.

1. Groundwood Printing and Uncoated Publication Paper

As much groundwood as possible is used in this grade to obtain printability, opacity, and low cost. Chemical fiber is blended with the groundwood fiber (mechanical pulp) to obtain the necessary tear, tensile, and burst strength required for the end-use application.

Within the numerous products included in groundwood printing and publication papers and their respective end-use requirements, the ratio of groundwood to chemical fiber decreases as the quality improves. A high-quality publication grade, such as "Time-Life paper" includes about 50% groundwood combined with a mixture of bleached softwood and hardwood chemical pulp. The chemical fiber component is about three-fourths softwood and one-fourth hardwood pulp, prepared by either the sulfite or kraft pulping process. One of the principal reasons for the comparatively high chemical fiber furnish is to carry the inorganic pigment fillers that are incorporated into the sheet. Some high-quality groundwood papers are coated with inorganic pigments.

Other grades within this category, e.g., catalog paper, typically have a higher groundwood content--about 65-70%. End-use requirements and cost considerations dictate the proportions of chemical and groundwood fibers used in each grade.

Old news could be used as a complete or partial replacement for the groundwood in these grades. Similarly, P/S and high-grade deinking could be used as a complete or partial replacement for the hardwood segment of the chemical fiber portion. Possible reduction in opacity is the major consideration when a high percentage of reworked news replaces virgin mechanical fiber. Tensile and tear strength are diminished when the chemical fiber is replaced with P/S and high-grade deinking S/F. Accordingly, replacement in these light-basis-weight grades is typically aimed at the substitution of the hardwood fraction only.*

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*Source: ADL personal communication with private firm making these grades from a combination of virgin groundwood, deinked pulp, and market pulp.

2. Newsprint

In newsprint manufacture, groundwood pulp (made almost exclusively with softwood) is combined with softwood chemical fiber. Groundwood pulp can be prepared in either stone grinders or refiners. Pulp yields are in the order of 93 to 95%. Softwood chemical pulp can be made by either the sulfite (unbleached) or kraft (semi-bleached) process. Typical yield via the sulfite process is about 62%, while that for semi-bleached kraft is 45%.

Typical northeastern and northwestern newsprint furnishes have about 15-25% sulfite chemical fiber; the remainder is mechanical fiber. In the South, the combination is 25-30% semi-bleached kraft and the rest pine groundwood.

The use of old news as a complete replacement for the virgin fiber furnish is well established. Garden State Paper Company operates mills in Garfield, N. J., Alsip, Ill., and Pomona, Calif. with a 100% old news furnish. Traditionally, a high-quality "super" news grade was used in this application. Specifications established by Garden State necessitated hand sorting to reduce the presence of contaminants to an acceptable level. The dealer received $5-7 per ton more for this superior grade than for the more traditional grade (No. 1 news).

More recently, the practice of using a substantial portion of deinked news as a fiber blend with virgin fiber has been established. Startup of a deinking facility at the Southwest Forest Industry mill at Snowflake, Arizona is scheduled for this year. Approximately 40% of the fiber furnish will consist of deinked news. It is also reported that Publishers Paper in Oregon will use a combination of two parts deinked news to one part virgin fiber. In both cases, we understand the mills will accept No. 1 news; additional cleaning equipment has been designed into the facilities to accommodate this grade.

3. Groundwood Specialties

This category includes a wide variety of groundwood-content grades, such as wallpaper, poster, white tablet, target, manila drawing, and colored specialties. As in newsprint manufacture, the practice of using secondary fiber in these applications is well established. Typically, the fiber furnish includes 15-20% bleached chemical market pulp, and the remainder is about equally divided between groundwood and deinked pulp. The recent scarcity and high price of virgin pulp has forced many of these producers to sharply reduce or even eliminate the use of virgin market pulp. However, groundwood specialties usually have a heavier basis weight than publication papers or newsprint, so the loss in opacity with the replacement of virgin groundwood with recycled news is not as significant.

Pulp substitute grades and high-grade deinking waste paper are used to supply the chemical fiber requirement. The need for cleanliness in the product rather than strength has been the principal factor hindering the extent of S/F usage; blending the latter with virgin groundwood and market pulp dilutes dirt and hence reduces the number of specks per unit area. The dirt content is related not only to the cleanliness of the incoming raw material, but also the sophistication of the cleaning equipment. These site-specific considerations are not amenable to this analysis.

E. TISSUE AND OTHER MACHINE CREPED PAPER

There are two major types of tissue in this functional group, namely, sanitary and nonsanitary. Sanitary tissue is by far the larger segment and represents the greater potential for secondary fiber consumption. The nonsanitary segment, which includes waxing tissue, wrapping, industrial cellulose, and numerous miscellaneous grades, actually uses a greater amount of S/F per unit of product, but it represents less than 7% of the total production of this functional group. For this reason, we have not included it in our analysis.

In the manufacture of most sanitary tissue products (toilet, facial, napkins, etc.), the sheet needs only to be strong enough to get it through the converting equipment. Since tensile strength is inversely related to softness, manufacturers strive to make the sheet as weak--hence as soft--as possible.

The fiber furnish for sanitary tissue is now mostly chemical pulp. The blends of groundwood and chemical fiber that were common 10-15 years ago have been displaced. The fiber blend is typically bleached sulfite and bleached kraft pulp. To obtain softness, the manufacturer includes as much hardwood pulp as possible, consistent with good performance on the converting machine. In facial tissue, for example, the furnish may include 40-50% hardwood pulp and the remainder softwood pulp. Amounts greater than 60% tend to weaken the sheet excessively and hinder performance on the converting machinery.

P/S and high-grade deinking secondary fiber provide an excellent furnish for tissue manufacture. The fact that the recycled fiber has been "reworked" reduces its bonding strength, thereby enhancing the softness of the sheet.

It is technically possible to make sanitary tissue from 100% S/F, and a number of small nonintegrated mills are doing so. However, a certain amount of strength is needed when the tissue passes through the converting machinery, so it is desirable to include some virgin softwood fiber.*

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* ADL private communication with Mr. M. Reuben, Technical Director, Erving Paper Company, Erving, Massachusetts.

Again, cleanliness of the raw material and the adequacy of the plant cleaning equipment are the major considerations.

In some of the low-grade tissue applications and toweling, a small quantity (5-20%) of groundwood is still used. The groundwood fiber may be supplied via virgin softwood mechanical pulp or deinked news.

F. FOLDING BOXBOARD

The folding boxboard functional group contains a wide variety of end products, each with different property requirements and potential for utilizing S/F. In this discussion, we will consider two principal subdivisions: solid bleached sulfate or SBS containing 85% or more bleached fiber) and combination or recycled folding boxboard.

1. Solid Bleached Sulfate (SBS) Board

As the name implies, SBS board is made up almost exclusively of virgin bleached kraft pulp. Blends of softwood and hardwood are used, the ratio depending upon the end-use requirements of the final product. In products such as milk carton stock where tear and tensile strength are especially important, the softwood content would be in the range of 75-80%; in other products, such as meat trays, where tensile strength is not important, about 20% softwood content would be used.

Historically, S/F has not been used in the manufacture of SBS board, because virgin fiber has been more economical. From a technical viewpoint, secondary fiber from P/S and deinking grades could be used as a partial or complete replacement for the hardwood content; the likelihood of this substitution is remote, however, because P/S and the high-grade deinking waste paper are in demand for applications with higher added value.

2. Recycled 18-Point Clay-Coated Folding Boxboard

At present, recycled-fiber folding boxboard is made up almost exclusively from secondary fiber. Prior to the sharp price increases for market pulp, it formed about 20% of the furnish for this type of boxboard. Under current economic conditions, virtually no market pulp is used.

A typical fiber furnish includes about 20% pulp substitute grades, 74% news and kraft clippings (80/20 ratio), and 6% clay coating (Figure VIII-1). Mixed waste, specifically office waste, is a candidate replacement material for No. 1 news in recycled board manufacture, but it has some technical/economic problems, such as the following:

- Quality - Office waste contains a larger percentage of contaminants than No. 1 news. For example, hot melt adhesives (in labels and envelopes) and waxes (in carbon papers) are found in office waste but are generally ex-

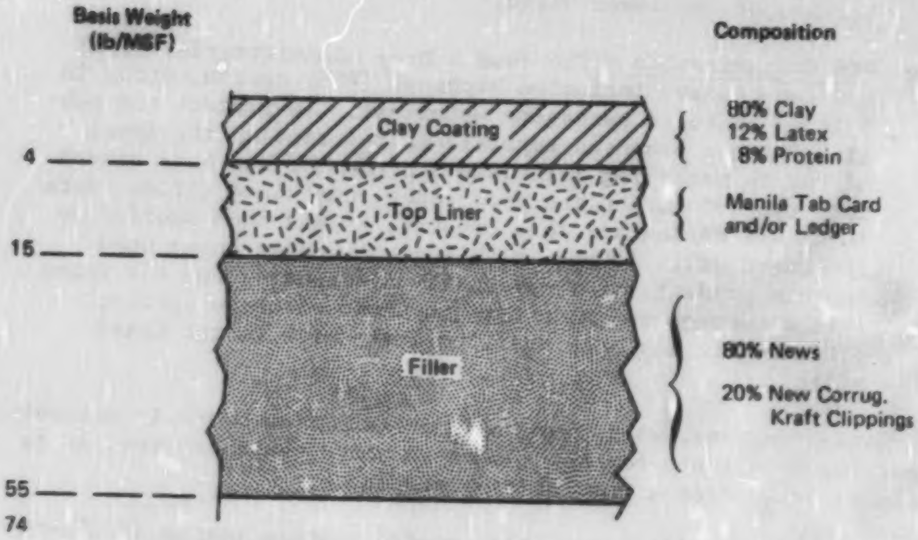

Basis Weight
(lb/MSF)
Composition
Clay Coating
80% Clay
12% Latex
8% Protein
4
Top Liner
Manila Tab Card
and/or Ledger
15
Filler
80% News
20% New Corrug.
Kraft Clippings
55
74

FIGURE VIII–1 COMPOSITION OF 18-POINT CLAY-COATED FOLDING BOXBOARD

cluded from No. 1 news. These undesirable materials can be removed by the stock preparation system, but additional cleaning facilities would probably have to be installed.

- Economy - The high groundwood content of folding boxes made with news filler produces low bulk, hence greater yield per ton of product. We believe that complete substitution of the mechanical fiber in waste news with the chemical fiber in office waste would reduce the bulk—hence reduce the area yield—per ton of board product. Traditionally, price adjustments are made to reflect yield; thus a potential saving in raw material cost may be offset by a reduction in selling price because of the lower yield.

- PCB Contamination - The Food & Drug Administration (FDA) has found polychlorinated biphenyl (PCB) contamination in folding boxboard packaging materials. To protect the public, FDA has proposed regulations restricting the level of PCB in packaging materials. Since PCB has been traced to a type of carbonless copy paper, and since office waste is likely to contain this product, it has been avoided by the board mills. However, FCB is no longer being used in this product; as it gradually disappears from the waste stream through normal attrition and selective sorting, office waste may once again be attractive to the board mills.

For the above reasons, we believe that while office waste is suitable as a partial substitute for No. 1 news in board manufacturing, it is unlikely to be used as a complete replacement.

In some packaging applications, clay-coated folding box is in direct competition with SBS board; in other applications, it is the preferred material because of its cost/performance properties. The recycled board, which is typically made on conventional cylinder machines or any of the numerous multi-ply formers, is made in a range of calipers from about 14-point (0.014 inch) to 45-point (0.045 inch); SBS board is usually made on a Fourdrinier machine in calipers from about 10- to 28-point. Thus, the products compete directly in the 14- to 28-point range; applications for 10- to 14-point and 28- to 45-point generally are served respectively by SBS and recycled board.

Where the two products do compete, the choice usually depends on the strength-to-weight ratio and its impact upon competitive cost. Typically, SBS board has a higher strength per unit of weight. The critical measure of the strength-to-weight characteristic of these materials is packaging stiffness, which is influenced by the forming technique (Fourdrinier, cylinder, or multi-ply former) as well as the type of fiber (virgin vs. recycled).

Figure VIII-2 illustrates the relationship between package stiffness and weight for virgin-fiber SBS board produced on a Fourdrinier machine and two typical recycled board products, one made on a conventional cylinder machine and the other on one of the newer multi-ply formers. Compared with SBS board, to achieve a 300 package stiffness, the weight "give-away" for a board made on a conventional cylinder machine is about 20%; that for one made on an improved multi-ply former, less than 10%. Hence, the newer equipment should make recycled board more competitive with virgin fiber SBS board. Table VIII-3 correlates the relationships among package stiffness, basis weight, and caliper.

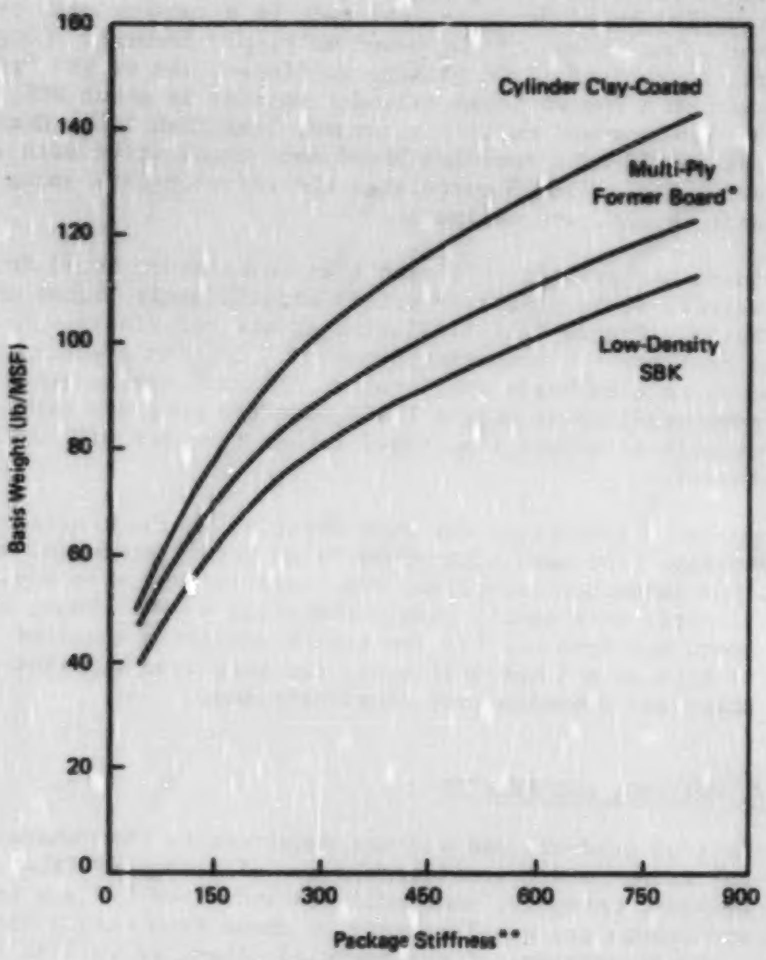
Because SBS board has greater stiffness than combination board for a given basis weight, it is generally priced significantly higher on a unit weight basis. Figure VIII-3 illustrates the relationship between stiffness and cost for the competing products. In this graph, prices are expressed on an area basis (dollars per thousand square feet) rather than on the more traditional weight basis, because most end users compare costs per unit of material packaged rather than per unit weight of packaging material.

Aesthetic appearance is another key consideration in the choice of a packaging material. For many high-added-value retail products, such as cosmetics and pharmaceutical supplies, SBS board is used even though it may be significantly more costly than combination board. Thus, while combination board may have all the functional qualities required for an end-use application at a lower unit cost, the perceived superior appearance of SBS board may outweigh cost considerations.

G. PRINTING, WRITING, AND RELATED

The wide variety of products and end-use requirements that characterize this functional group permit considerable use of secondary fiber. As in the folding boxboard category, some products made from S/F are in direct competition and others are supplementary to those from virgin fiber. The intrinsic characteristics of the recycled fiber, as well as the end-use requirements of the product and the ability of the manufacturer to get maximum utility from the S/F, influence the substitutability of the two fibers.

Products in this category contain no groundwood, because the latter turns yellow when exposed to light. They are made from a combination of softwood and hardwood chemical pulps plus varying quantities of inorganic pigment coatings. Printability, formation, opacity, uniformity, and permanence are important in this product category. As much hardwood pulp is used as possible to obtain these quality characteristics, softwood pulps are added to develop the required tear and tensile strength and to carry the coating weight as well as the nonbonding inorganic filler material. The actual proportions of softwood and hardwood pulps depend on the end-use application and can vary from relatively low quantities of hardwood pulp in high-grade writing papers to 100% southern hardwood chemical pulp in some business papers.



*Assumes basic board density @ 3.5 lb/point/MSF, coating weight @ 8 lb/MSF

**Package Stiffness = (MD Stiffness)$^{0.33}$ X (CMD Stiffness)$^{0.667}$

Source: Fibreboard Corp.

FIGURE VIII–2 PACKAGE STIFFNESS OF SELECTED BOARD SAMPLES

TABLE VIII-3

STIFFNESS CHARACTERISTICS OF SBS AND RECYCLED FOLDING BOXBOARD

(Basis weight in lb/MSF; caliper in mils)

Package[a] Stiffness	Low-Density Clay-Coated SBK (@ 3.8 Density)		Cylinder Clay-Coated (@ 3.85 Density)		Clay-Coated Multi-ply Former Board[b]			
	BW	Cal.	BW	Cal.	BW	Fiber Wt.	Cal.	Density
31	38.0	10.0	48.0	12.5	46.2	38.2	11.5	4.01
54	45.6	12.0	57.8	15.0	54.0	46.0	13.7	3.93
86	53.2	14.0	67.4	17.5	61.7	53.7	15.9	3.87
128	60.8	16.0	77.0	20.0	69.4	61.4	18.1	3.83
182	68.4	18.0	86.6	22.5	77.0	69.0	20.3	3.79
250	76.0	20.0	96.3	25.0	84.7	76.7	22.5	3.76
333	83.6	22.0	105.9	27.5	92.4	84.4	24.7	3.74
432	91.2	24.0	115.5	30.0	100.0	92.0	26.9	3.72
549	98.8	26.0	125.1	32.5	107.7	99.7	29.1	3.70
686	106.4	28.0	134.8	35.0	115.4	107.4	31.3	3.69
843	114.0	30.0	144.3	37.5	123.0	115.0	33.5	3.68
Grain Ratio	1.66		3.80		3.1			

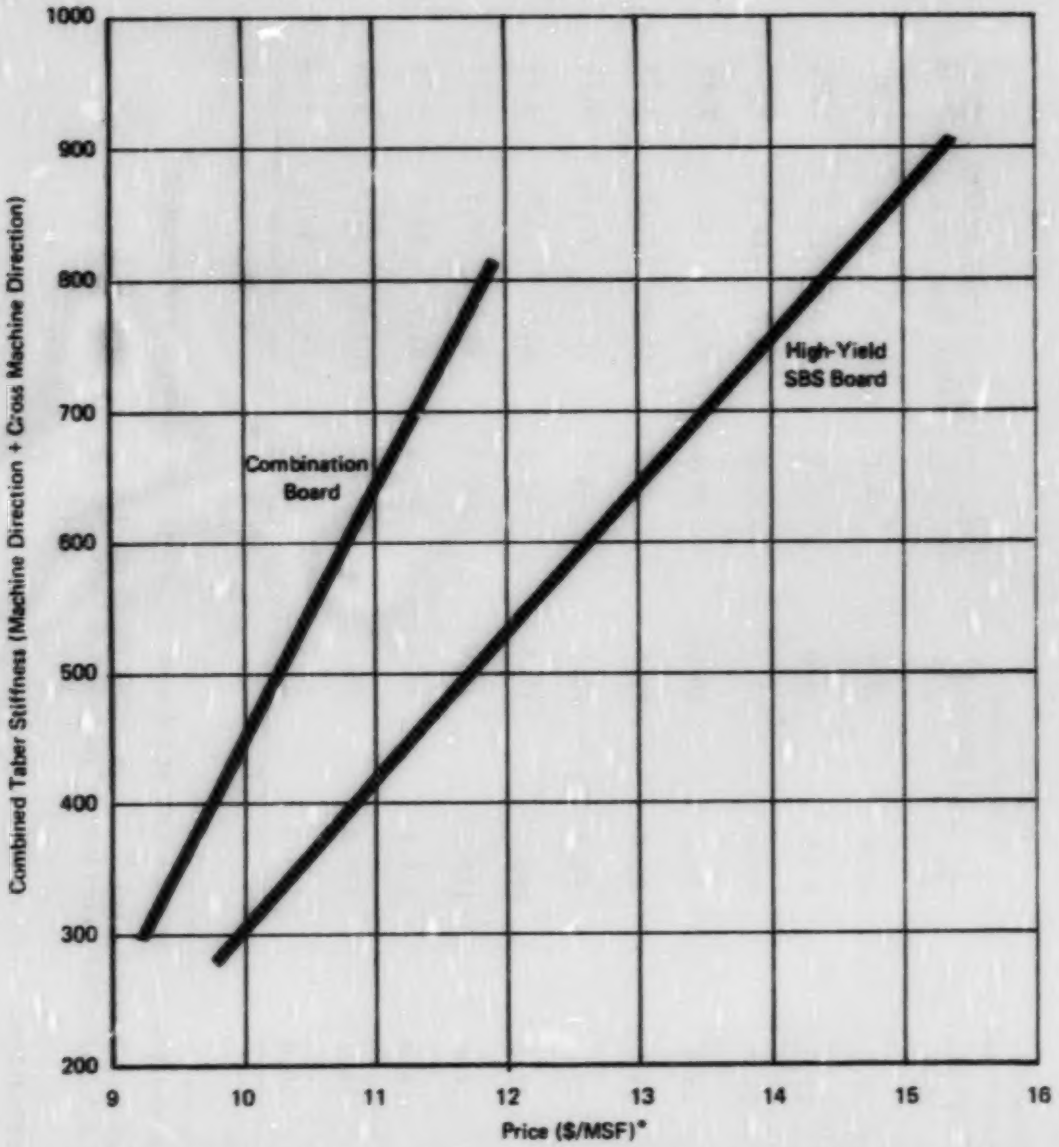
---

[a] Package stiffness is a combination of MD & CMD stiffness as related to package performance:

$$\text{Package stiffness} = (\text{MD stiffness})^{0.333} \times (\text{CMD Stiffness})^{0.667}$$

[b] Basic board density @ 3.5 lb/pt/MSF, coating weights @ 8.0 lb/MSF total. (5.0 lb on top, 3.0 lb on bottom)

SOURCE: Fibreboard Corporation.



*Based on the following selling prices for rolls: SBS – $350/ton; Combination – $255/ton.

Source: Arthur D. Little, Inc., test results and calculations; 1974 list prices.

FIGURE VIII–3 RELATIONSHIP OF STIFFNESS TO PRICE FOR SBS AND COMBINATION BOARD

The use of secondary fiber is well established in many specific grades of this functional group. Typically, S/F is used to replace the hardwood portion of the virgin fiber, but it is sometimes used as the sole fiber in the furnish.

Table VIII-4 shows the results of laboratory comparisons of paper made from S/F and from various grades of bleached kraft. The following is an excerpt from a letter by the Technical Director of Bergstrom Paper Company, a leading manufacturer of printing and writing paper from secondary fiber, who supplied these data:

> "This information was extracted from a study that we did in 1971 to compare the properties of our deinked secondary fiber (identified in data as bookstock) with the properties of various grades of softwood and hardwood bleached kraft that we were purchasing at the time. The data represent the test results of laboratory pulp evaluation on each pulp (including bookstock) using the Valley beater and TAPPI standard methods. Data at "0" minutes and "10" minutes beating time are compiled; 10 minutes time in the Valley beater most closely simulates the degree of refining done by our paper machine refiners on virgin fiber.
>
> "In general terms, the types of waste paper being furnished to our deinking plant at the time that this study was made included book, ledger, kraft, and tab card.
>
> "It is rather difficult to characterize the strength properties of our deinked fiber in quantitative terms without generalizing. However, we regard bookstock as comparable to bleached hardwood kraft as far as strength properties are concerned; the enclosed data bears this out. Over the years, we have developed grades which suit the characteristics of this bleached secondary fiber and many of these grades are comprised of 100% deinked fiber.
>
> "In the manufacture of paper, we will furnish as much deinked fiber as possible in keeping with the end use requirements of the grade, its runability on the paper machine and the availability of fiber from our deinking plant. For lightweight papers (30-40 lb.) less deinked fiber will be furnished than for heavier weights (50 lb. and above). Refining of the deinked fiber portion of the furnish is minimal (tickler refining after blending with refined virgin fiber) while the virgin fiber portion is given a greater degree of refining; all to obtain as good forming characteristics as possible.
>
> "Many of the grades that we manufacture are for web offset applications and rarely have we experienced problems with web strength which could be related to the use of deinked fiber."

TABLE VIII-4

STRENGTH AND OPTICAL PROPERTIES OF SELECTED VIRGIN AND SECONDARY FIBER PULPS

(Handsheets prepared and tested in accordance with TAPPI Standard T220m-60)

Property	Beating Time[a] (min)	Softwood[b]	Hardwood[c]	S/F
Canadian Standard Freeness (ml)	0	674-748	581-680	504
	10	632-704	492-628	388
Specific Volume (cm^3/gm)	0	1.75-2.22	1.69-2.19	1.90
	10	1.57-1.87	1.54-1.89	1.69
Burst Strength (psi)	0	20-61	10-38	51
	10	72-136	27-86	80
Tear Strength (gm)	0	148-252	36-112	118
	10	138-238	72-110	98
Fold Endurance (no. of folds)	0	3-53	0-8	15
	10	109-879	4-67	55
Breaking Length (m)	0	1706-4263	1005-2439	3090
	10	3531-7090	2637-5813	5150
Stiffness ($cm^3/100$)	0	98-111	85-107	93
	10	98-116	85-98	102
Opacity (%)	0	72-78	76-82	81
	10	68-73	73-81	78
Brightness (%)	0	86-89	87-90	84
Porosity (sec)	0	0.1-2.4	0.5-3.3	4.9
	10	0.6-6.9	1.4-8.9	16.4

---

[a] On Valley laboratory beater

[b] Range of values for pulps from four major suppliers

[c] Range of values for pulps from five major suppliers

Source: K. L. Maves, Director of Research and Development, Bergstrom Paper Company.

H. INDUSTRIAL PACKAGING, CONVERTING, AND MISCELLANEOUS

As with printing and writing paper, a wide variety of products and end-use requirements are included in this functional group. The use of S/F varies from 0% for those applications in which a high strength-to-weight ratio is required (e.g., saturating paper for tube stock in the manufacture of electric fuses) to 100% in specific grades of combination tube, can, and drum stock for mechanical applications.

Two specific grades, unbleached kraft bag paper and tube paper, were selected for economic analysis in Section IX; accordingly, our discussion of the potential substitutability of virgin with S/F will be directed to these products.

Unbleached bag paper for multiwall sacks and grocery sacks is made primarily from unbleached softwood kraft pulp. In certain specific applications, northern softwood pulpwood species are used to obtain maximum strength-to-weight ratio. The paper is also creped while on the paper machine to permit extra elongation. This "extensible kraft bag paper" represents a substantial portion of this functional group. S/F is not well suited for this application.

For less demanding applications within this subcategory, such as notion bags, strength requirements are lower and some virgin hardwood fiber pulp or S/F pulp can be blended with the virgin softwood fiber. The actual proportion would be dictated by the end-use requirements; for our economic comparison we used 30%. Waste paper grades used in this application include P/S and OCC (specifically, pre-consumer waste box plant cuttings).

In tube paper, tear strength, tensile strength, and rigidity are all important characteristics of the product. Their relative importance is influenced by the specific end-use application.

An example of an application in which tensile strength is important is that for unbleached kraft tube paper used in the manufacture of phenolic-resin-impregnated tube stock for electrical fuses. In this application, high tensile strength is required in the saturation step; rigidity is imparted via the resin. Cleanliness and absence of electrolytes are other key requirements of the pulp furnish for these applications; hence, the possible variability of these qualities in S/F would make it unsuitable for this application.

On the other hand, there are other applications for tube paper in packaging and materials handling in which S/F is a suitable replacement material. These applications include fiber drums and core stock. In these applications, tensile strength need not be so high; rigidity is the critical property. A wide variety of waste paper grades are used here, ranging from a high percentage of news in tube stock for toilet tissue and roll toweling cores to zero news and a high percentage of OCC (specifically, double-lined kraft clippings) in tube stock for paper rolls, fiber drums, etc.

In our economic comparison, we assumed an unbleached "kraft" tube paper that might be used as core stock in gift-wrap paper or linoleum tubes. We estimated that 20% double-lined kraft clippings and 80% P/S grades could be used in these applications. Other fiber furnishes could be postulated for different applications.

I. CONSTRUCTION PAPER AND PAPERBOARD

As indicated in Table VIII-2, the level of S/F usage in this group varies greatly from one product to another. In this functional group, it ranges from 0% for insulation board and hardboard to 100% for gypsum linerboard. Recent experimental work carried out by the Forest Products Laboratory indicates that it is technically possible to use up to 25% OCC in medium-density hardboard without reducing its strength properties.* In other work by FPL, waxed container waste was used in the manufacture of hardboard. Up to 50% fiber replacement was found to be possible without loss in drainage characteristics of the stock on the forming machine or reduction of the physical properties of the resultant product.** About 25% OCC and 75% news is used in the manufacture of gypsum linerboard.

From a technical point of view, we know of no obstacle to utilizing S/F (specifically old news) in the manufacture of insulation board. The use of S/F in the manufacture of insulation board has been tried experimentally, but we do not believe it is being done on a commercial scale.

In the section on Process Economics, we have considered the manufacture of roofing felt, a major component of the construction paper subcategory. Tensile strength and absorptivity are key requirements of this grade. About 55% S/F (44% mixed waste and 11% OCC) and 45% mechanical fiber is used in this grade. Increasing the S/F content significantly above this level is reported to reduce tensile strength below that required in the asphalt saturation step.*** The prospect of removing the weaker medium fraction from the liner fraction in the recovery of OCC suggests that higher proportions of S/F may be possible, but sufficient data are not now available to validate that hypothesis.

J. SUMMARY

The previous grade-by-grade analysis supports our initial statement that the practicality of substituting virgin fiber with secondary fiber is not amenable to precise analysis. The quality of the recovered S/F, and hence the quality of the recycled product, are influenced by the characteristics of the original product, the history of the recovered waste paper, and the ability of the reprocessor to recover maximum utility from the fiber. Therefore, it would be misleading to state specific percentage ranges that would apply to the substitution of secondary for virgin fiber in each paper and paperboard product.

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* ADL private communication with retired mill manager of a roofing felt manufacturing facility.

** FPL Research Paper 254, "Dry Formed Medium Density Hardboard from Urban Forest Material."

*** P. E. Steinmetz, "Hardboard: a Potential Outlet for Waxed Containers," TAPPI, Vol. 57, No. 2 (February 1974) p. 74.

However, it can be said that there is significant commercial experience to validate the use of a high percentage (in some instances 100%) of secondary fiber in the manufacture of certain products; these products are listed below, together with an indication of the grades of waste paper that can be used. Further information on typical furnishes for various products containing waste paper is given in Appendix C-4.

	OCC	News	Deinking	P/S	Mixed
Linerboard	√				
Corrugating Medium	√	√			√
Newsprint		√			
Napkins, Box Facial and Toilet Tissue		√	√	√	
Printing & Writing (selected grades)			√	√	
Coated & Uncoated Groundwood Papers		√	√	√	
Folding Boxboard (combination)	√	√			√
Combination Tube, Can & Drum Paper	√	√			√
Gypsum Linerboard & Construction Paper	√	√			√

There are experimental data to indicate that S/F can be used in major applications in which it was not previously used, such as medium-density hardboard. Thus, greater usage of S/F has not been blocked by a lack of technical suitability, but by commercial and economic problems.

Table VIII-5 summarizes the virgin fiber and S/F fiber furnishes used in the economic analyses of selected paper and paperboard products in Section IX. The range of substitution is indicated by the inclusion of examples using 100% S/F. This is not intended to imply that equivalent product qualities will be achieved in all cases; rather, it indicates that some products made from S/F have discrete end-use applications suited to their price/quality structure.

TABLE VIII-5

SUMMARY OF FIBER FURNISHES USED IN THE ECONOMIC ANALYSIS OF SELECTED PAPER AND PAPERBOARD PRODUCTS

Functional Group and Grade	Virgin Fiber	S/F - Virgin Fiber Blend: S/F	S/F - Virgin Fiber Blend: Virgin Fiber
CONTAINERBOARD			
Kraft Linerboard	80% SW UBK 20% HW UBK	20% OCC	80% SW UBK
Jute Liner	-	100% OCC	-
Semi-Chemical Corr. Medium	85% NSSC HW 15% New Kraft Clippings	33% OCC 10% Kraft Clippings	57% NSSC HW
Bogus Medium	-	100% OCC	-
GROUNDWOOD PAPER			
Newsprint	25% SW SBK/UBS 75% MF	1) 33% No. 1 News	17% SW SBK 50% MF
	-	2) 100% No. 1 News	-
Uncoated Printing Paper	35% SW SBK 65% MF	1) 33% No. 1 News	26% SW SBK 41% MF
	-	2) 80% No. 1 News 20% Ledger	-
TISSUE AND OTHER MACHINE CREPED PAPER			
Toilet/Facial	50% SW BK 50% HW BK	1) 13.2% IBM Card 13.2% Ledger 6.6% No. 1 News	33.5% SW BK 33.5% HW BK
	-	2) 40% IBM Card 40% Ledger 20% No. 1 News	-
FOLDING BOXBOARD			
18-Point Clay-Coated	-	Top Liner-100% Ledger Filler Liner - 80% News 20% OCC	-
SBS Board	60% SW BK 40% HW BK	-	-

TABLE VIII-5 (Cont'd)

SUMMARY OF FIBER FURNISHES USED IN THE ECONOMIC ANALYSIS OF SELECTED PAPER AND PAPERBOARD PRODUCTS

Functional Group and Grade	Virgin Fiber	S/F - Virgin Fiber Blend	
		S/F	Virgin Fiber
PRINTING, WRITING AND RELATED			
Bond Paper	50% SW BK 50% HW BK	1) 13.2% IBM Cards 13.2% Ledger 6.6% No. 1 News	33.5% SW BK 33.5% HW BK
	-	2) 40% IBM Cards 40% Ledger 20% No. 1 News	-
Book Paper	20% SW BK 80% HW BK	1) 20% IBM Cards 20% Ledger 10% No. 1 News	50% HW BK
	-	2) 40% IBM Cards 40% Ledger 20% No. 1 News	-
INDUSTRIAL PACKAGING AND CONVERTING			
Unbleached Kraft Bag Paper	100% SW UBK	1) 6% Double Kraft lined corr. cuts 24% P/S UBK grades	70% SW UBK
	-	2) 20% Double Kraft lined corr. cuts 80% P/S UBK grades	-
Tube Paper	100% SW UBK	1) 14% Double Kraft lined corr. cuts 56% P/S UBK grades	30% SW UBK
	-	2) 20% Double Kraft lined corr. cuts 80% P/S UBK grades	-
CONSTRUCTION PAPER AND PAPERBOARD			
Roofing Felt	-	44% Mixed Waste 11% OCC	45% SW UBK

SOURCE: ADL estimates and information derived in interviews with industry representatives previously identified.

Key:
GW = Groundwood
SBK = Semi-bleached kraft
SW = Softwood
S/F = Secondary Fiber
HW = Hardwood
BK = Bleached kraft
UBK = Unbleached kraft
CF = Chemical fiber, either kraft or sulfite
MF = mechanical fiber, either stone or refiner GW

Table VIII-6 lists some of the leading manufacturers of selected paper and paperboard products. While all producers that use secondary fiber as a partial substitute or complete replacement for virgin fiber are not included in this list, it provides a representative sample of major companies that do extensive recycling of waste paper.

TABLE VIII-6

COMPANIES UTILIZING SECONDARY FIBER IN THE MANUFACTURE OF PAPER AND PAPERBOARD PRODUCTS*

CORRUGATED SHIPPING CONTAINERS

Alton Box Board Co., Alton, Ill.
Bird and Son, Inc., East Walpole, Mass.
Boise Cascade Corp., Boise, Idaho
Consolidated Packaging Corp., Chicago, Ill.
Consolidated Papers, Inc., Wisconsin Rapids, Wis..
Container Corp. of America, Chicago, Ill.
Continental Can Co. Inc., New York, N.Y.
Crown Zellerbach Corp., San Francisco, Calif.
Diamond National Corp., New York, N.Y.
Federal Paper Board Co. Inc., Montvale, N.J.
Fibreboard Corp., San Francisco, Calif.
Fleming and Sons, Inc., Dallas, Texas
Flintkote Co., White Plains, N.Y.
Hoerner Waldorf Corp., St. Paul, Minn.
Inland Container Corp., Indianapolis, Ind.
Mead Corporation, Dayton, Ohio
Menasha Corp., Neenah, Wis.
Owens-Illinois Inc., Toledo, Ohio
Packaging Corp. of America, Evanston, Ill.
St. Regis Paper Co., New York, N.Y.
Simkins Industries, Inc., New Haven, Conn.
Stone Container Corp., Chicago, Ill.
Time Container Corp., Chicago, Ill.
Union Camp Corp., Wayne, N. J.
Unitec Board and Carton Co., Ridgefield, Park, N.J.
Weston Paper and Mfg. Co., Terre Haute, Ind.
Westvaco Corp., New York, N.Y.

SOLID FIBER SHIPPING CONTAINERS

Alton Box Board Co., Alton, Ill.
Bird and Son, Inc., East Walpole, Mass.
Consolidated Packaging Corp., Chicago, Ill.
Consolidated Papers, Inc., Wisconsin Rapids, Wis.
Container Corp. of America, Chicago, Ill.
Continental Can Co., Inc., New York, N.Y.
Fibreboard Corp., San Francisco, Cal.

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* Partial listing

TABLE VIII-6 (Cont'd)

COMPANIES UTILIZING SECONDARY FIBER IN THE MANUFACTURE OF PAPER AND PAPERBOARD PRODUCTS

SOLID FIBER SHIPPING CONTAINERS (Cont'd)

Inland Container Corp., Indianapolis, Ind.
Mead Corporation, Dayton, Ohio
Menasha Corp., Neenah, Wis.
Packaging Corp. of America, Evanston, Ill.
St. Regis Paper Co., New York, N.Y.
Stone Container Corp., Chicago, Ill.
John Strange Paper Co., Appleton, Wis.
Union Camp Corp., Wayne, N.J.
Westvaco Corporation, New York, N.Y.

BOXBOARD CARTONS

Alton Box Board Co., Alton, Ill.
Austell Box Board Corp., Austell, Ga.
Beloit Boxboard Co., Beloit, Wis.
Beveridge Paper Co., Indianapolis, Ind.
Carolina Paper Board Corp., Charlotte, N.C.
Columbia Corp., Chatham, N.Y.
Consolidated Packaging Corp., Chicago, Ill.
Consolidated Papers, Inc., Wisconsin Rapids, Wis.
Container Corp. of America, Chicago, Ill.
Crown Zellerbach Corp., San Francisco, Calif.
Diamond National Corp., New York, N.Y.
Downington Paper Co., Downington, Pa.
Federal Paper Board Co., Inc., Montvale, N.J.
Fibreboard Corp., San Francisco, Calif.
Fleming and Sons, Inc., Dallas, Texas
Flintkote Co., White Plains, N.Y.
Georgia-Pacific Corp., Portland, Oregon
Hoerner-Waldorf Corp., St. Paul, Minn.
Lowe Paper Co., Ridgefield, N.J.
Macandrews and Forbes Co., Camden, N.J.
Mead Corporation, Dayton, Ohio
Michigan Carton Co., Battle Creek, Mich.
Packaging Corp. of America, Evanston, Ill.
St. Regis Paper Co., New York, N.Y.
Simkins Industries, Inc., New Haven, Conn.
Stone Container Corp., Chicago, Ill.
John Strange Paper Co., Menasha, Wis.
Tennessee Paper Mills, Inc., Chattanooga, Tenn.
Union Camp Corp., Wayne, N.J.
United Board and Carton Corp., Ridgefield Park, N.J.
Westvaco Corp., New York, N.Y.
Whippany Paper Board Co., Inc., Whippany, N.J.

TABLE VIII-6 (Cont'd)

COMPANIES UTILIZING SECONDARY FIBER IN THE MANUFACTURE OF PAPER AND PAPERBOARD PRODUCTS

PRINTING AND WRITING PAPER

Allied Paper Corp., Kalamazoo, Mich.
Bergstrom Paper Co., Neenah, Wis.
Fitchburg Paper Co., Fitchburg, Mass.
Newton Falls Paper Co., Newton Falls, N.Y.
Oxford Paper Co., Richmond, Va.
Rising Paper Co., Housatonic, Mass.
Riverside Paper Corp., Appleton, Wis.
St. Regis Paper Co., New York, N.Y.
Simpson Lee Paper Co., Kalamazoo, Mich.
Tileston & Hollingsworth Co., Boston, Mass.
Valentine Pulp & Paper Co., Lockport, La.
Ward Paper Co., Merrill, Wis.

NEWSPRINT AND OTHER GROUNDWOOD PAPER

Garden State Paper Co., Inc., Garfield, N.J.
Hennepin Paper Co., Little Falls, Minn.
Manistique Pulp and Paper Co., Manistique, Mich.
Southwest Forest Industries, Inc., Phoenix, Ariz.

TISSUE, TOWELING, AND OTHER MACHINE CREPED PAPER

Berkshire Tissue Mills, New York, N.Y.
Crown Zellerbach, Carthage, N.Y.
Fort Howard Paper Co., Green Bay, Wis.
Hudson Pulp and Paper Co., New york, N.Y.
Kimberly-Clark Corp., New York, N.Y.
Marcal Paper Mills, East Paterson, N.J.
Morgan Mills, Lititz, Pa.
Patrician Paper Co., New York, N.Y.
Romar Tissue Mills, Inc., Wheelwright, Mass.
Scott Paper Co., Philadelphia, Pa.
Swanee Paper Corp., New York, N.Y.
Wisconsin Tissue Mills, Inc., Menasha, Wis.

TABLE VIII-6 (Cont'd)

COMPANIES UTILIZING SECONDARY FIBER IN THE MANUFACTURE OF PAPER AND PAPERBOARD PRODUCTS

FINE AND SPECIALTY PAPER

Eagle-A Paper Mills, Holyoke, Mass.
L. L. Brown Paper Company, Adams, Mass.
Crane and Co., Inc., Dalton, Mass.
Esleeck Manufacturing Company, Turners Falls, Mass.
Fox River Paper Corp., Appleton, Wis.
Gilbert Paper Company, Menasha, Wis.
The Harding-Jones Paper Co., Middleton, Ohio
Hawthorne Paper, Kalamazoo, Mich.
Howard Paper Mills, Dayton, Ohio
Millers Falls Paper Co., Millers Falls, Mass.
Parsons Paper, Holyoke, Mass.
Rising Paper Co., Housatonic, Mass.
Rochester Paper Co., Adams, Mass.
Simpson-Lee Paper Company, San Francisco, Calif.
Southworth Company, West Springfield, Mass.
Strathmore Paper Company, West Springfield, Mass.
Byron Weston Company, Dalton, Mass.
Whiting-Plover Paper Company, Stevens Point, Wis.

MOULDED PULP CONTAINERS AND TRAYS

Alton Box Board Co., Alton, Ill.
Bemis Co., Minneapolis, Minn.
Diamond National Corp., New York, N.Y.
Hawley Products Co., St. Charles, Ill.
Keyes Fibre Corp., Waterville, Me.
Packaging Corp. of America, Evanston, Ill.

NOTE: Many products used for industrial and home construction purposes are also made from recycled material--insulation, construction board, roofing, sound-absorbing material, padding, etc.

SOURCE: National Association of Secondary Material Industries, Inc., New York, N. Y.

Section IX is
bound separately
in Volume Two

X. POTENTIAL FOR SECONDARY FIBER USE, 1973-1983

A. APPROACH AND BASIS OF EVALUATION

This section attempts to assess the levels of reuse that secondary fiber might attain by 1983. The 1973 Capacity Survey of API -- the most current data available during the study period -- was used to project both waste paper consumption and paper production through 1977.* The capacity data (although unfortunately not the data on waste paper use) are relatively reliable; lead time requirements are such that any new capacity decisions made now would not be in effect until later than 1977.**

Various factors that determine the competitive position of virgin versus secondary fiber have been described in the preceding sections and taken into consideration in this qualitative analysis. However, numerous intangible and unpredictable factors will also influence the industry's ultimate decision. These factors include (1) the overall state of the U.S. economy, (2) the rate of economic recovery from the current depressed level, (3) local, state, and national regulations on solid waste disposal and the resultant impact upon the cost and availability of waste paper, (4) the influence of the cost and availability of capital on new plant decisions, (5) possible discriminatory freight rates for virgin fiber products, and (6) changes in paper and paperboard specifications prompted by attempts to save energy or encourage recycling. As noted earlier, this assessment assumes that no financial incentives or other legislative stimuli will be enacted to increase the use of secondary fiber, that the national economy will begin to recover in the last half of 1975, and that there will be no major disruption of business activity for the duration of the period studied.

Since these and other implicit factors are critical to assessing the potential usage of secondary fiber, this analysis can indicate only the potential for recycling.

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* In API's 1974 Capacity Survey, projected waste paper usage and capacity expansion have been revised downward significantly.

** Reductions in capacity through 1977 have recently been announced due to unfavorable business conditions. These changes include indefinite delays in a few projects and stretched-out completion dates for others. Although the affected plants form a significant part of the announced year-end capacity for 1977 (about 15%), they constitute less than 2% of the total U.S. capacity; hence the API Capacity Survey data still provide a valid basis for analysis. In addition to the delays and stretchouts, a number of secondary fiber mills have closed since the time of our original analysis (1974) and may not reopen. Obviously, the papermaking capacity reported for 1977 would have to be modified to reflect these closures.

Also fundamental to the entire assessment of opportunities for greater waste paper utilization is the unlikelihood that virgin pulp mills will be idled or production reduced simply to provide an opportunity for processing secondary fiber. The cost of idling or curtailing pulping production would erode any savings resulting from the use of secondary fiber. Some pulp mills will be shut down for other reasons, such as for pollution abatement or technical or economic obsolescence; however, our emphasis is on the likelihood that new pulping capacity, prompted by overall increased market demand for the original products or by the retirement of obsolescent pulp mills, will be captured by secondary fiber.

In this section we first review the factors that were used in making the qualitative assessment of the potential recovery rate that is technically feasible and economically possible without deterioration of product quality. We then summarize the potential usage in 1983 and analyze the rationale for the projections in greater detail.

B. FACTORS CONSIDERED IN ESTIMATING POTENTIAL FUTURE WASTE PAPER USAGE

1. Comparative Economics

A number of factors have contributed to the increase in the use of waste paper in the pulp and paper industry during 1973 and the first half of 1974. One of the most important of these has been the scarcity of market pulp, accompanied by a rapid rise in its price. This situation strongly stimulated the demand for waste paper, specifically the pulp substitutes and high-quality deinking grades. The projected deficiency of the market pulp supply, both in the United States and on the world market, is expected to continue through the 1980 period and sustain the incentive for finding an alternative raw material supply.

Another cause of the sharp increase in waste paper usage during this period has been the skyrocketing cost of building new grass-roots facilities. This investment has escalated not only because of inflation, but also because of larger unit size manufacturing facilities and additional capital requirements for pollution abatement and energy conservation.

Combined, these factors have increased the capital intensivity of pulp and paper manufacturing facilities far more rapidly than construction costs have risen: while the construction cost index* has increased about 40% from 1969 to 1974, the investment for a new mill has doubled. For example, the investment for a 650-tpd "economic size" plant for bleached kraft in 1969/1970 was about $70 million; today, the capital requirement for an 800-tpd "economic size" plant would be over $140 million (not including escalation during construction).

A fourth consideration is the cost and limited availability of wood resources (particularly softwood) to support a new minimum-economic-size grassroot operation. While the total availability of wood resources is ample to supply industry needs, it has become increasingly difficult and costly to obtain a sufficiently large, concentrated supply for a new pulping facility.

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* C.E. Plant Cost Index, Chemical Engineering, March 17, 1975

The combination of the above factors has led the industry to seek out opportunities for incremental expansion of its pulping facilities, which is conveniently possible through the usage of secondary fiber to supplement a virgin fiber supply.

The replacement of pulp mill capacity with secondary fiber capacity is another source of potential growth for secondary fiber. The retirement of pulp mill capacity due to technical and economic obsolescence (effluent limitations, low capacity and efficiency, etc.) is not unusual. To replace this capacity with new virgin-fiber pulping in reasonable volume requires major capital expenditures and significantly increased marketing ability. It is unlikely that retired pulp mill capacity could be economically replaced with new capacity at the same scale, or that a company could economically erect a single facility to replace capacity retired at several locations, except in very special situations.

We have prepared economic models of a new, integrated pulping facility based on various blends of virgin and secondary fiber. These models also provide a means for estimating the cost and profitability of adding incremental secondary-fiber capacity to a specific virgin pulp mill whose conditions are known. The economics of incremental expansion in existing mills may be expected to vary widely, since the technical feasibility, capital, and operating costs are all highly dependent on specific mill conditions; however, recent industry trends clearly indicate the attractiveness of incremental capacity expansion and the merits of secondary fiber as a supplementary raw material for such expansion, particularly in linerboard and newsprint production.

As discussed in connection with the economic models presented in Section IX, the profitability of new secondary-fiber capacity is less attractive than new, integrated virgin-fiber pulping and papermaking capacity for all products except newsprint. However, ROI is not the sole criterion for judging the attractiveness of using secondary fiber. The more modest size of a secondary fiber installation (300-400 tpd) allows smaller steps of capacity increase than for a 500-1000 tpd virgin pulp mill. Because of its smaller size and lower unit capital requirements, a secondary fiber mill has a much smaller capital requirement ($30-$40 million).

The actual magnitude of total capital requirements for virgin fiber pulping could be even higher than the $100-200 million we have estimated (excluding any capital associated with wood resources). Thus, the higher profitability of a virgin pulp facility is available only to those companies that have the ability to raise these sums and companies that can absorb large capacity increases. A tabulation of the investment, capital intensivity, and profitability of selected products studied in this analysis will be found in the section on Process Economics (see Volume II, Table IX-N-1).

In addition to competing directly with products from integrated virgin fiber pulping and papermaking, secondary fiber products also compete with products from nonintegrated mills that use virgin fiber market pulp as a raw material. The nonintegrated paper industry is difficult to characterize because of its wide variety of products and processes. Some nonintegrated mills are owned by large pulp producers to serve as a market for their pulp, and the selection of market pulp over secondary fiber may be influenced by mill ownership; however, a sizable portion of the nonintegrated paper industry is not connected with virgin fiber or wood resources.

The products and processes we selected for comparison of nonintegrated production indicate the clear economic superiority of secondary fiber as compared with virgin market pulp sources. Since this difference will continue and be emphasized by the reduced supply and increased prices of market pulp, the high-grade pulp substitute and deinking waste papers will find a ready market in the nonintegrated paper mills, as long as the latter remain economically viable.

2. Product Quality

Waste paper may be reused for either 100% secondary fiber products or as a supplement to virgin fiber for blended products. Products using waste paper fall into two relatively distinct groups:

- Those that do not compete with virgin fiber products and thus have their own price/quality structure based on performance alone (noncompetitive products are primarily 100% recycled fiber);
- Those that are directly competitive with virgin fiber products and whose quality standards are therefore determined by the latter (competitive products may be either 100% recycled or blended fiber).

In some cases, most notably tissue and printing/writing paper products, where a broad spectrum of quality is represented, waste paper reuse may fall into both the competitive and noncompetitive categories. Thus, there are specific grades within these groups whose quality requirements can be met with 100% S/F or blends of virgin and secondary fiber, as well as grades whose quality requirements are best met with virgin fiber.

In preparing our estimates of process and product economics, we have made judgments with respect to prices and quality on the basis of current technology and market conditions. For those specific grades in which products made from secondary fiber are considered to be of lower quality than virgin fiber products, the selling prices are lower. Even for those grades where quality differences are insignificant (e.g., newsprint or corrugating medium) market conditions may at times require discounting the price to secure market outlets.

While noncompetitive markets provide a stable outlet for significant quantities of secondary fiber products, the major opportunity for increased utilization is in direct competition with virgin fiber products, where an increased share of the market can be achieved. In some product areas, technical improvements are required to eliminate quality and performance distinctions, but in others the technology is known and available--economics simply has not favored the use of secondary fiber.

3. Accessibility of Secondary Fiber

a. Available Grades

Products made from OCC and news can compete with virgin fiber products, and significant quantities of fiber are available; thus, there are expansion opportunities in these grades. Pulp substitute and deinking grades, on the other hand, have a very high existing utilization and thus low net available collectable tonnage, as would be expected from their strong competitive position with respect to virgin fiber market pulp as a raw material for nonintegrated papermaking. Thus, unless new sources of these waste paper grades are developed, their limited availability will constrain their increased usage. (See Section VII-D.)

Mixed grades have high availability; however, their increased usage is limited by technical considerations. Since these grades are cheap and readily available, they are already used to the maximum extent technically possible. The large available tonnage does not represent a significant growth opportunity under present conditions, since usage would be limited by growth of the existing products. However, one segment of mixed paper--specifically office waste--contains a large proportion of waste potentially suitable for high-quality deinking grades. If this portion of the existing mixed waste stream could be segregated or reclassified economically, it would find an immediate market as a replacement for market pulp.

Clearly, therefore, the opportunity for any significant increase in waste paper recycling rests with the bulk grades of waste paper, namely OCC and news.

b. Economic Accessibility

A waste paper recovery operation does not require a large investment and can operate efficiently at a volume as small as 50 tpd. Therefore, it is economically feasible to recover the collectable tonnage of waste paper within an area of relatively small population. Papermaking is another matter, however; it is such a highly capital-intensive industry that it requires a much larger scale of operation. Unit costs may vary 5-10%, depending on the volume of waste paper that a collector handles, but a paper mill that reduced its output from, say, 300-400 tpd to 150-250 tpd could expect its unit costs to rise 20-30%. Thus, a small metropolitan area that might support a recovery operation would probably not support

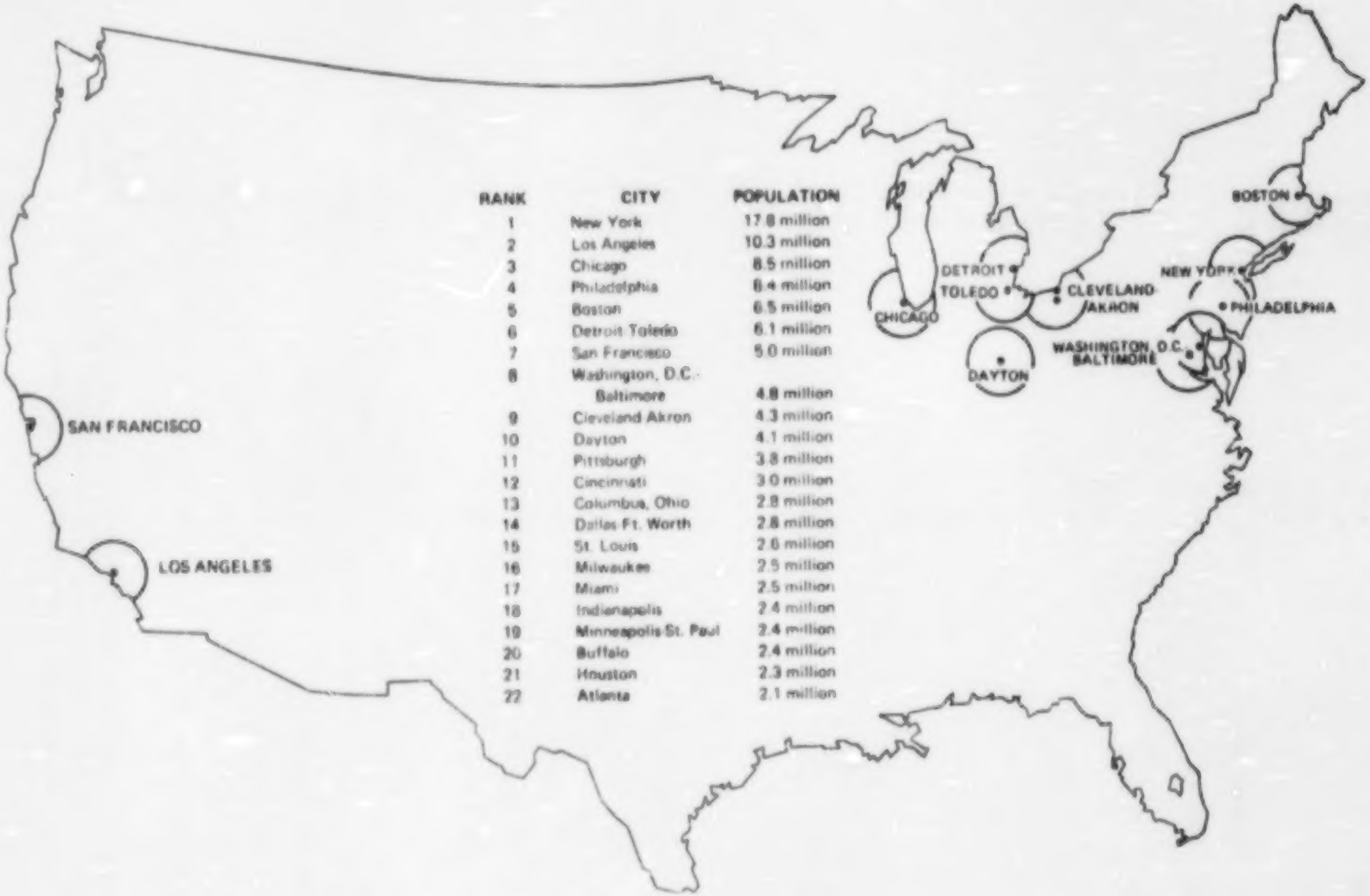
a paper mill based on secondary fiber. Furthermore, because transportation cost is a major component of the total delivered cost of the low-added-bulk waste paper grades, it is impractical to ship this material to a distant mill. For these reasons, the collectable tonnage — i.e., the quantity of waste paper that is available for recovery — is often not economically accessible for reuse in papermaking.

Accordingly, one of the prerequisites of economic accessibility is a large, concentrated population that can provide at least the minimum "critical mass" of waste paper to support economical papermaking operations. As an aid in evaluating the potential for obtaining this critical mass of waste paper from a given area, we have used the concept of the "90-minute market," which is the area that can be reached by highway transport, traveling at legal speed, in an hour and a half. (With today's high-speed transportation systems, the size of a market is measured in terms of time, not mileage.) Figure X-1 shows the location of the most densely populated 90-minute markets in the United States, and Table X-1 groups the top twenty of these areas according to the geographic sections used in this analysis.

The waste paper requirements that cannot be obtained from within the 90-minute market must be brought to the mill, largely by rail, from collection points that may be hundreds of miles away. To describe the zone surrounding the 90-minute market and extending perhaps 600 miles from the mill, we have applied the concept of the "second-morning-service (S-M-S) market"; the ten most densely populated S-M-S markets are shown in Figure X-2. Analysis of waste paper transportation costs indicates that shipping by rail to the midpoint of the S-M-S market costs about the same as truck transportation within the 90-minute market.

In our cost calculations for newsprint and recycled containerboard, we have assumed that about 60% of the mill's waste paper supply would come from within the 90-minute market and that about 40% of the finished products would be sold there; the S-M-S market would supply the remainder of the waste paper and buy the other 60% of the finished products. These assumptions were made to optimize transportation costs and the profitability of the mill.

Neither "collectable tonnage" nor "economically accessible tonnage" reflects the willingness of the original generator of waste paper to practice source segregation, which is essential for economical recovery. We cannot judge whether a given population center has the potential to supply enough additional waste paper to meet a new mill's requirements unless we know both the current rate of recovery and the maximum rate that is possible in that area. Substantial "spot" data are available on levels of recovery that have been achieved in various suburban communities, but few (if any) definitive assessments have been made of maximum recovery rates obtainable on a sustained basis; for this percentage, we must rely on informed judgment. For the purposes of this analysis, we have assumed a maximum 50% recovery of the total theoretical supply of OCC and news. This is equivalent to 58% of the collectable tonnage of OCC and 65% of the collectable tonnage of news, since the


SAN FRANCISCO
LOS ANGELES
CHICAGO
DETROIT
TOLEDO
DAYTON
CLEVELAND-AKRON
WASHINGTON, D.C.-BALTIMORE
NEW YORK
PHILADELPHIA
BOSTON

RANK	CITY	POPULATION
1	New York	17.8 million
2	Los Angeles	10.3 million
3	Chicago	8.5 million
4	Philadelphia	8.4 million
5	Boston	6.5 million
6	Detroit Toledo	6.1 million
7	San Francisco	5.0 million
8	Washington, D.C.-Baltimore	4.8 million
9	Cleveland Akron	4.3 million
10	Dayton	4.1 million
11	Pittsburgh	3.8 million
12	Cincinnati	3.0 million
13	Columbus, Ohio	2.8 million
14	Dallas Ft. Worth	2.8 million
15	St. Louis	2.6 million
16	Milwaukee	2.5 million
17	Miami	2.5 million
18	Indianapolis	2.4 million
19	Minneapolis St. Paul	2.4 million
20	Buffalo	2.4 million
21	Houston	2.3 million
22	Atlanta	2.1 million

Source: Computations based on 1972 Sales Management Survey of Buying Power.

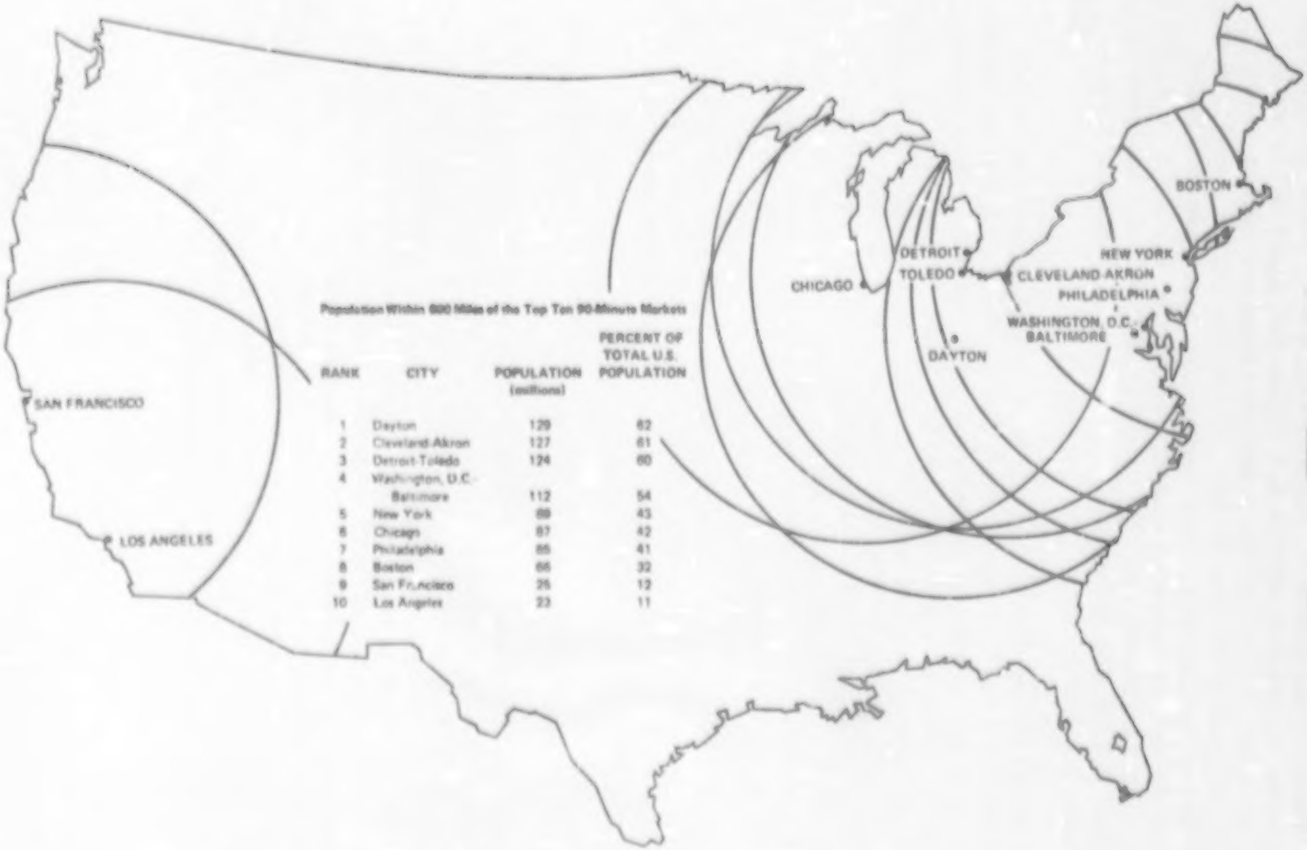
FIGURE X–1 LEADING 90-MINUTE MARKETS

TABLE X-1

DISTRIBUTION OF LEADING 90-MINUTE MARKET AREAS BY MAJOR GEOGRAPHIC SECTIONS

Section	Population	
	Millions	% of Total Section
NORTHEAST		
New York	17.8	35.7
Philadelphia	8.4	16.9
Boston	6.5	13.1
Pittsburgh	3.8	7.6
Buffalo	2.4	4.8
Total 90-Minute	38.9	78.1
Total Section	49.8	
NORTH CENTRAL		
Chicago	8.5	14.8
Detroit	6.1	10.6
Cleveland	4.3	7.5
Dayton	4.1	7.1
Cincinnati	3.0	5.2
Columbus	2.8	4.9
St. Louis	2.6	4.5
Milwaukee	2.5	4.3
Indianapolis	2.4	4.2
Minneapolis-St. Paul	2.4	4.2
Total 90-Minute	38.7	67.3
Total Section	57.5	
SOUTH		
Washington D.C.-Baltimore	4.8	7.4
Dallas-Fort Worth	2.8	4.3
Miami	2.5	3.9
Houston	2.3	3.5
Atlanta	2.1	3.2
Total 90-Minute	14.5	22.3
Total Section	64.9	
WEST		
Los Angeles	10.3	28.6
San Francisco	5.0	13.9
Total 90-Minute	15.3	42.5
Total Section	36.0	
Total U.S. 90-Minute	107.4	51.6
Total U.S. Population	208.2	

Source: Population data from Statistical Abstract of the United States, U.S. Department of Commerce, 1973; 90-Minute Market data based on 1972 Sales Management Survey of Buying Power


SAN FRANCISCO
LOS ANGELES
CHICAGO
DETROIT
TOLEDO
DAYTON
CLEVELAND AKRON
WASHINGTON, D.C.
BALTIMORE
PHILADELPHIA
NEW YORK
BOSTON

Population Within 600 Miles of the Top Ten 90-Minute Markets

RANK	CITY	POPULATION (millions)	PERCENT OF TOTAL U.S. POPULATION
1	Dayton	129	62
2	Cleveland-Akron	127	61
3	Detroit-Toledo	124	60
4	Washington, D.C.-Baltimore	112	54
5	New York	89	43
6	Chicago	87	42
7	Philadelphia	85	41
8	Boston	66	32
9	San Francisco	25	12
10	Los Angeles	23	11

Source: 1972 Sales Management Survey of Buying Power.
All figures exclusive of Canadian population.

FIGURE X-2 LEADING "SECOND MORNING SERVICE" MARKETS

collectable tonnage of OCC averages 86% of the theoretical supply and the collectable tonnage of news averages 77% of the theoretical supply.

With these concepts in mind, and a knowledge of the per capita consumption of the specific original paper product, one can derive the population needed to support a papermaking operation. This permits a rough screening of candidate sites within the larger geographic areas in which additional collectable tonnage is determined to be available. Clearly, the top ten market areas shown in Figures X-1 and -2 would be the most likely candidates for new or additional sites for paper mills using waste paper; however, to be in the prime northeastern market region, a mill need not be located in one of the particular cities named. Southwest Pennsylvania, for example, does not appear as a specific S-M-S market, but it is within reach of nearly 70% of the nation's population (Figure X-3). It is also within 500 miles of 65% of U.S. business establishments, 75% of all employment, and 71% of the nation's value added by manufacturing.

Another factor affecting the economically accessible tonnage is the tradeoff between the cost of additional raw material and the potential savings from a larger scale of operations. For example, the economic analysis of jute liner manufacture (Section IX-E) indicated a net increase in the pre-tax margin of some $2 million per year if the scale of operation were increased from 300 tons per day (100,000 tons per year) to 450 tpd (150,000 tpy). This implies that the hypothetical jute linerboard mill would find it more profitable to pay up to $40 per ton more for a 50,000-tpy incremental supply of OCC than to operate at a lower scale of operation.

Obviously, other factors also influence the selection of scale of operation; the preceding discussion merely illustrates some of the considerations involved in assessing the quantity of waste paper that is economically accessible for reuse.

c. Use of S/F as a Supplementary Furnish

The "critical mass" required for economical reuse of paper as a fiber supplement is generally substantially lower than for 100% secondary fiber reuse. As a supplement, waste paper could be economically attractive at a scale of operation of 25-50 tpd; as a sole source of fiber, 200 to 300 tpd would be more typical. It is the scale of the total papermaking operation that affects economic feasibility, not the scale of waste paper repulping alone. Thus, smaller quantities of waste paper can be economically reused as supplementary furnish for a larger papermaking operation. The same principles of economic accessibility discussed above apply here, but a less concentrated supply is needed. A considerably larger fraction of the residual collectable tonnage is available for economic reuse as supplementary furnish than for 100% recycled products.

In the sections that follow, we analyze the potential opportunity for the reuse of the major waste paper grades in the various studied functional groups.

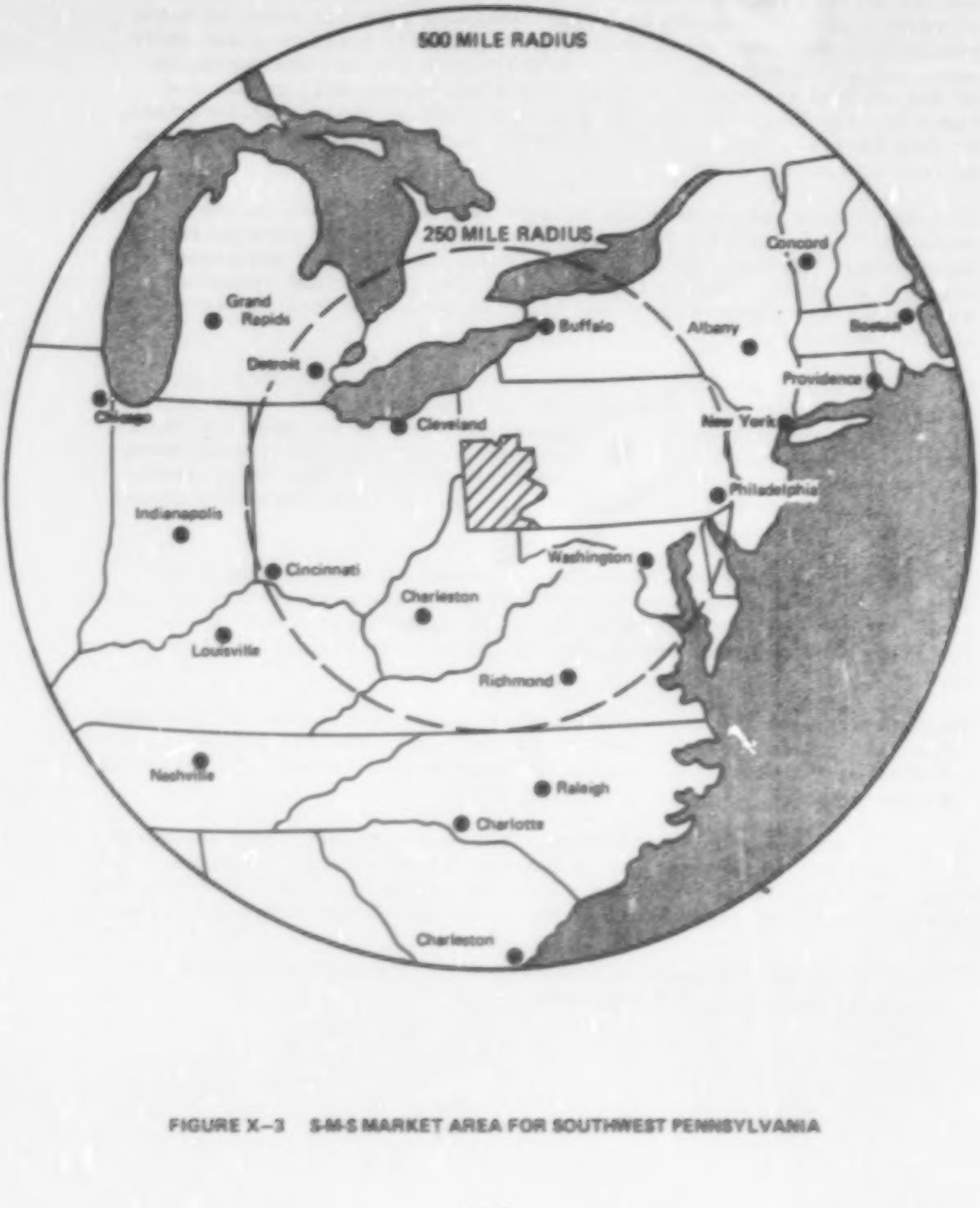

500 MILE RADIUS
250 MILE RADIUS
Concord
Grand Rapids
Buffalo
Albany
Boston
Detroit
Providence
Chicago
Cleveland
New York
Philadelphia
Indianapolis
Cincinnati
Washington
Charleston
Louisville
Richmond
Nashville
Raleigh
Charlotte
Charleston

FIGURE X–3 S-M-S MARKET AREA FOR SOUTHWEST PENNSYLVANIA

C. OVERALL POTENTIAL WASTE PAPER USAGE

Based upon the above-listed considerations, we derived the 1983 level of waste paper usage. More specifically, we estimated the quantity of waste paper that would be economically accessible to support recycled paper and paperboard manufacture, the amount that could be used in the individual grades without deterioration of product quality, the 1977-1983 increase in capacity to supply the projected paper consumption, and the demographic data which influence the cost and availability of waste paper. A comparison of ROI between virgin and recycled paper manufacture was used as one criterion to identify possible areas where waste paper use might increase. Another criterion was the magnitude of the capital investment required for a new virgin mill versus one based on recycling. Within the bounds defined by these considerations, we then made a judgment of the potential for increased waste paper use in each functional group.

As noted, since the preparation of this report, data have become available which indicate that the 1977 levels for paper consumption, papermaking capacity, and waste paper usage used in this assessment were all too high. Obviously, therefore, the projections contained herein must be interpreted in the light of these new data and others as they become available.

Figure X-4 shows, in part, the additional amount of secondary fiber that is projected to be used in each functional group by 1977. This information is based on consumption figures estimated by the American Paper Institute (API) in its 1973 Capacity Survey which we apportioned among the various product groups on the basis of published data where available, or our assessment of the categories in which the secondary fiber was likely to be used.*

This graph also shows the increases in production that we expect by 1977. This is also based on the API survey of new capacity and expansion scheduled for completion by that year. We apportioned these increases among the product groups and estimated the corresponding production in 1977.

Similarly, Figure X-4 shows the potential additional amount of secondary fiber that could be used in each functional group by 1983 and our projections of the additional production requirements to meet the estimated apparent demand.

It should not be inferred from Figure X-4 that the additional secondary fiber will be used exclusively in the new capacity. The intent is simply to show how much more secondary fiber might be used in each of the studied functional groups to meet the fiber requirement resulting from

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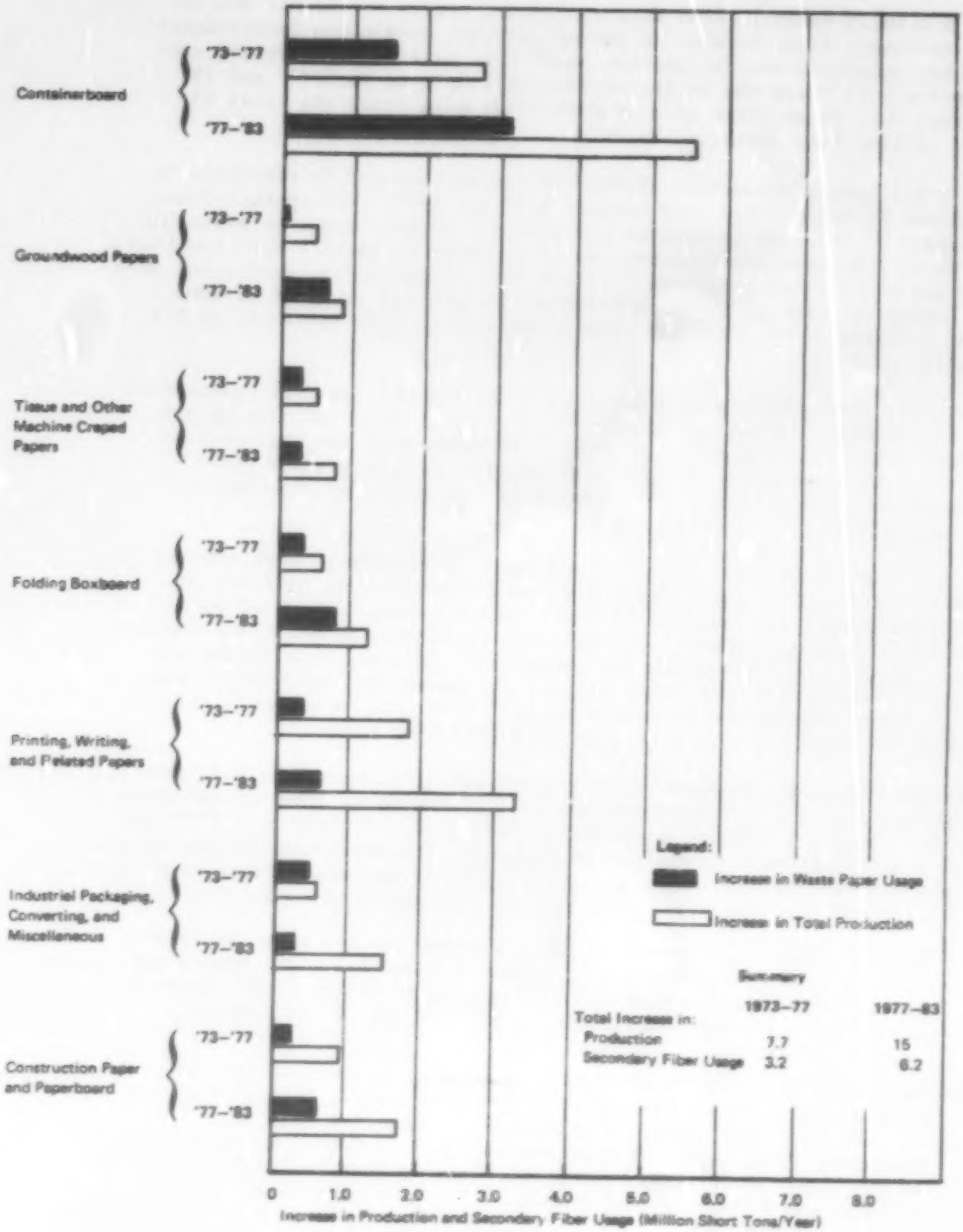
* The 1974 Capacity Survey projects significantly smaller increases in waste paper usage and capacity.



Basis: Total Increase at End of Studied Period

Source: 1973–1977, API 1973 Capacity Survey, reaggregated by ADL; 1977–1983, ADL Projections

FIGURE X-4 COMPARISON OF POTENTIAL SECONDARY FIBER USAGE WITH PROJECTED INCREASE IN PRODUCTION

the growth in demand. From this standpoint, it is irrelevant whether the secondary fiber is used in new or existing production facilities;* the key questions are (a) whether total U.S. paper and paperboard consumption will reach the estimated 75.4 million tons in 1977 and (b) whether U.S. consumption of secondary fiber will reach the total of 17.5 million tons projected by API.

The total annual production of the U.S. paper industry is projected to increase by 7.7 million tons between 1973 and 1977. The containerboard category is expected to account for some 2.7 million tons, or about 35% of this, and therefore presents one of the most attractive opportunities for secondary fiber. Between 1977 and 1983, overall U.S. production is projected to increase by an additional 15.0 million tons; we believe that containerboard will also account for 35% of this increase, or 5.5 million tons.

Secondary fiber could gain a large share of the new capacity (additional or replacement) in the containerboard category. It could also gain a larger share in the groundwood paper area because of the availability of old news to support additional production and the greater cost-competitiveness of this fiber compared with that of the alternative raw material.

On the other hand, the overall percentages of secondary fiber used in tissue and printing and writing paper may decline; this reflects our assessment that the industry is exploiting existing sources of pulp-substitute and high-grade deinking stock as rapidly as possible, leaving less reserve supplies to support expansion. However, regulations are under consideration that would require all government agencies to practice source segregation of office waste.** Their enactment could significantly increase the supply of high-grade deinking waste.

Whereas Figure X-4 is based upon projections of increases in U.S. production, Figure X-5 illustrates the role of secondary fiber in relation to the total U.S. demand (consumption) of paper and paperboard products. Since 1973 data show historical performance, the demand represents actual paper and paperboard consumption. Estimates of secondary fiber usage in 1977 and 1983, on the other hand, assume that paper consumption will

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* The distribution of secondary fiber between new and existing facilities is briefly discussed in Sections X-D and X-E with respect to its two major applications -- namely, the recycling of old corrugated containers for containerboard and the use of old news in recycled newsprint.

** "Materials Recovery: Solid Waste Management Guidelines for Source Separation," U.S. Environmental Protection Agency, Federal Register, Vol. 40, No. 181 (Sept. 17, 1975), pp. 42986-42990. See also SCS Engineers, "Analysis of Source Separate Collection of Recyclable Solid Waste--Office Buildings," report to Resource Recovery Division, Office of Solid Waste Management Programs, U.S. Environmental Protection Agency, October 1975.

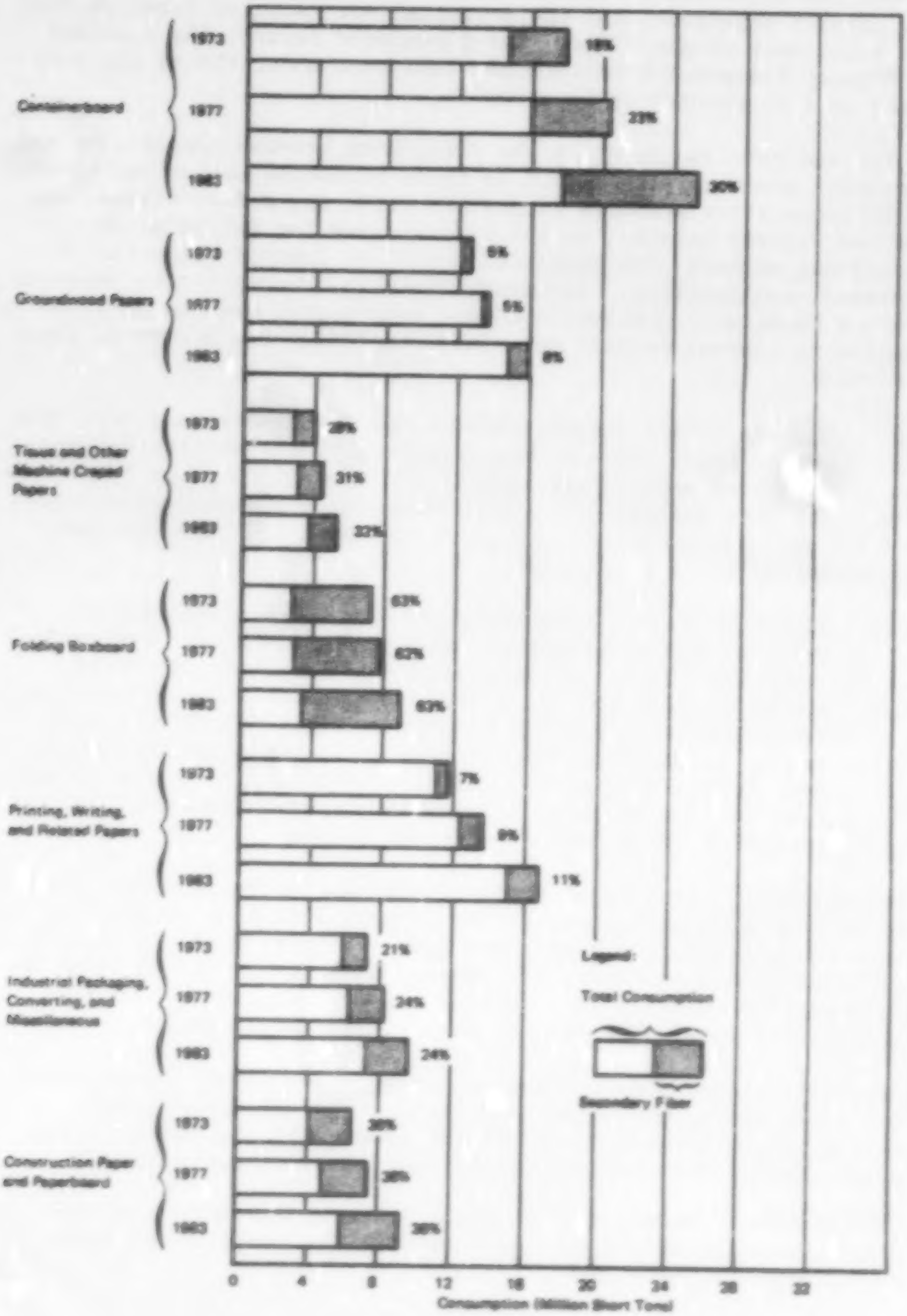

FIGURE X-5 PRESENT AND POTENTIAL USE OF SECONDARY FIBER IN STUDIED FUNCTIONAL GROUPS

equal market demand projections for the original products. These figures reveal a substantial dissimilarity in the potential for secondary fiber penetration of the various product groups. Again, they reflect our considered opinion regarding the availability of the appropriate waste paper grade to support expansion, and the potential for recycled fiber to displace or supplement virgin fiber. For groundwood papers, the contrast between Figures X-4 and X-5 reflect the fact that about 65% of all newsprint used in this country is imported.

Figures X-4 and X-5 also point up the difference between competitive and noncompetitive products with regard to their projected use of secondary fiber. In competitive products (containerboard, newsprint, tissue, and printing and writing papers), secondary fiber has the potential to capture additional markets; its penetration will be limited primarily by its economical availability. Secondary fiber in noncompetitive products, on the other hand, will probably not show substantial growth, as it is not expected to capture markets but simply to follow the growth of those that now exist.

Tables X-2, -3, and -4 are supporting data for Figures X-4 and X-5. They are based on waste paper usage by waste paper grade in various original products as first reported by McClenehan* and our estimates of fiber substitution. The data include historical performance and projected demand through 1977 as reported by API; projections beyond 1977 are ADL estimates of potential waste paper usage.

Since the various sources of information are not always complete or use the same segregation of products, these tables represent our estimates rather than hard data. We have based the projected growth of waste paper reuse, particularly in recycled newsprint and containerboard, on the conditions discussed earlier in this analysis. Growth in noncompetitive grades is based on demand, with waste paper mix determined from McClenehan and API data plus consideration of the fact that demand for OCC and news by containerboard and newsprint mills may result in some replacement elsewhere, by a variety of waste grades.

The distribution by waste paper grade in noncompetitive products is intended as an approximation only. The primary intent of tabulating these data is to indicate the relative levels of growth in noncompetitive products where demand is limiting, compared with the growth in containerboard, newsprint, tissue, and printing and writing, where the economical availability of fiber is the main constraint on market penetration.

To put the 1983 projections of waste paper usage in proper perspective, Table X-5 shows their relationship to the quantity of the original products and to the estimated collectable tonnage of the corresponding waste paper grade. This table shows high utilization rates for OCC

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* W. S. McClenehan, "Consumption of Paper Stock by U.S. Mills in 1969 and 1970," Division of Information Services, The Institute of Paper Chemistry, Appleton, Wisconsin, 1971.

TABLE X-2

1973 PAPER AND PAPERBOARD CONSUMPTION AND WASTE PAPER CONSUMPTION
(000 tons)

Functional Group and Grade	Consumption	Waste Paper Usage				
		Total	OCC	News	P/S	Mixed
1. CONTAINERBOARD						
Linerboard (virgin)	11,340	500	500	-	-	-
Linerboard (comb.)	284	340	340	-	-	-
Corrugating Medium (NSSC)	4,302	900	900	-	-	-
Corrugating Medium (comb.)	981	1,200	1,200	-	-	-
Container Chipboard	247	270	90	180	-	-
Other Unbleached Kraft Board	574	-	-	-	-	-
TOTAL CONTAINERBOARD	17,700	3,210	3,030	180		
2. GROUNDWOOD PAPERS						
Newsprint	10,726	490	-	360	-	130
Printing Papers	1,560	90	-	15	75	-
TOTAL GROUNDWOOD	12,300	580	-	375	75	130
3. TISSUE AND OTHER MACHINE CREPED PAPERS						
Tissue	4,000	1,180	120	100	860	100
4. FOLDING BOXBOARD						
Combination	2,678	3,200	500	700	900	1,100
Bleached (SBS)	3,655					
Milk and Food Service		200	70	-	40	90
Nonbending and other combination	990	1,200	200	400	-	600
TOTAL FOLDING BOXBOARD	7,300	4,600	770	1,100	940	1,790
5. PRINTING, WRITING, AND RELATED (EXCL. GROUNDWOOD PRINTING)	11,800	850	-	-	800	50

TABLE X-2 (Cont'd)

1973 PAPER AND PAPERBOARD CONSUMPTION AND WASTE PAPER CONSUMPTION
(000 tons)

	Consumption	Waste Paper Usage				
		Total	OCC	News	P/S	Mixed
6. INDUSTRIAL PACKAGING, CONVERTING & MISC.						
Packaging & Converting	3,805	240	20	20	150	50
Special Industrial	478	40	-	-	40	-
Tube, Can, Drum (virgin)	220	-	-	-	-	-
Tube, Can, Drum (comb.)	600	1,015	600	130	85	200
& other Packaging	2,165					
Molded Pulp Products (incl. fiber pipe)	?	200	-	100	100	-
TOTAL INDUSTRIAL	7,300	1,495	620	250	375	250
7. CONSTRUCTION PAPER AND PAPERBOARD						
Gypsum Linerboard	1,050	1,100	500	250	100	250
Construction Paper	1,812	1,300	250	200	50	800
Insulation & Hardboard	3,746	-	-	-	-	-
TOTAL CONSTRUCTION	6,600	2,400	750	450	150	1,050
TOTAL PAPER AND PAPERBOARD	67,000	14,315	5,290	2,455	3,200	3,370

Source: Consumption figures from 1973 API Capacity Survey, reallocated by ADL to the functional groups and grades shown here, based on "Consumption of Paper Stock by U.S. Mills in 1969 and 1970" (W. S. McClenahan)

TABLE X-3

1977 PAPER AND PAPERBOARD CONSUMPTION AND POTENTIAL WASTE PAPER CONSUMPTION

(000 tons)

Functional Group and Grade	Consumption	Waste Paper Usage				
		Total	OCC	News	P/S	Mixed
1. CONTAINERBOARD						
Linerboard (virgin)	12,680	940	940	-	-	-
Linerboard (comb.)	550	650	650	-	-	-
Corrugating Medium (NSSC)	4,530	1,150	1,150	-	-	-
Corrugating Medium (Comb.)	1,360	1,600	1,600	-	-	-
Container Chipboard	280	300	100	200	-	-
Other Unbleached Kraft Board	640	-	-	-	-	-
TOTAL CONTAINERBOARD	20,000	4,640	4,440	200	-	-
2. GROUNDWOOD PAPERS						
Newsprint	11,900	540	-	410	-	130
Groundwood Papers	1,700	100	-	20	80	-
TOTAL GROUNDWOOD	13,600	640	-	430	80	130
3. TISSUE AND OTHER MACHINE CREPED PAPERS						
Tissue	4,500	1,420	150	120	1,020	130
4. FOLDING BOXBOARD						
Combination	2,900	3,500	600	840	880	1,180
Bleached (SBS) Milk and Food Service	3,960	220	80	-	40	100
Nonbending and other combination	1,020	1,200	200	400	-	600
TOTAL FOLDING BOXBOARD	7,900	4,920	880	1,240	920	1,880
5. PRINTING WRITING AND RELATED (EXCL. GROUNDWOOD PRINTING)	13,600	1,200	-	-	1,140	60

TABLE X-3 (Cont'd)

1977 PAPER AND PAPERBOARD CONSUMPTION AND POTENTIAL WASTE PAPER CONSUMPTION
(000 tons)

Functional Group and Grade	Consumption	Waste Paper Usage				
		Total	OCC	News	P/S	Mixed
6. INDUSTRIAL PACKAGING, CONVERTING & MISC.						
Packaging & Converting (Incl. virgin tube, can & drum)	4,400	280	20	20	170	70
Special Industrial	600	50	-	-	50	-
Tube, Can, Drum (comb.) & other Packaging	3,150	1,450	980	150	100	220
Molded Pulp Products (incl. fiber pipe)	?	200	-	100	100	-
TOTAL INDUSTRIAL	8,200	1,980	1,000	270	420	290
7. CONSTRUCTION PAPER AND PAPERBOARD						
Gypsum Linerboard	1,100	1,200	550	270	110	270
Construction Paper	2,060	1,500	280	220	60	940
Insulation & Hardboard	4,400	-	-	-	-	-
TOTAL CONSTRUCTION	7,600	2,700	830	490	170	1,210
TOTAL PAPER AND PAPERBOARD	75,400	17,500	7,300	2,750	3,750	3,700

Source: Consumption figures from 1973 API Capacity Survey, reallocated by ADL to the functional groups and grades shown here, based on "Consumption of Paper Stock by U.S. Mills in 1969 and 1970" (W. S. McClenehan)

TABLE X-4

1983 PAPER AND PAPERBOARD CONSUMPTION AND POTENTIAL WASTE PAPER CONSUMPTION
(000 tons)

Functional Group and Grade	Consumption	Waste Paper Usage				
		Total	OCC	News	P/S	Mixed
1. CONTAINERBOARD						
Linerboard (virgin)	16,510	1,700	1,700	-	-	-
Linerboard (comb.)		1,800	1,800	-	-	-
Corrugating Medium (NSSC)	7,340	1,500	1,500	-	-	-
Corrugating Medium (Comb.)		2,200	2,200	-	-	-
Other Unbleached Kraft Board	800	-	-	-	-	-
Container Chipboard	350	380	130	250	-	-
TOTAL CONTAINERBOARD	25,000	7,580	7,330	250	-	-
2. GROUNDWOOD PAPERS						
Newsprint	13,820	1,130	-	1,000	-	130
Groundwood Papers	1,980	120	-	20	100	-
TOTAL GROUNDWOOD	15,800	1,250	-	1,020	100	130
3. TISSUE AND OTHER MACHINE CREPED PAPERS						
Tissue	5,200	1,650	170	140	1,180	160
4. FOLDING BOXBOARD						
Combination	3,310	4,000	600	900	1,000	1,500
Bleached (SBS) Milk and Food Service	4,520	250	80	-	50	120
Nonbending and other Combination	1,170	1,400	220	450	-	730
TOTAL FOLDING BOXBOARD	9,000	5,650	900	1,350	1,050	2,350
5. PRINTING, WRITING AND RELATED (EXCL. GROUNDWOOD PRINTING)	16,800	1,800	-	-	1,700	100

TABLE X-4 (cont'd)

1983 PAPER AND PAPERBOARD CONSUMPTION AND POTENTIAL WASTE PAPER CONSUMPTION
(000 tons)

Functional Group and Grade	Consumption	Waste Paper Usage				
		Total	OCC	News	P/S	Mixed
6. INDUSTRIAL PACKAGING, CONVERTING & MISC.						
Packaging & Converting (Incl. virgin tube, can & drum)	5,240	330	20	20	190	100
Special Industrial	710	60	-	-	60	-
Tube, Can, Drum (comb.) & other packaging	3,750	1,700	1,100	180	120	300
Molded Pulp Products (incl. fiber pipe)	?	200	-	100	100	-
TOTAL INDUSTRIAL	9,700	2,290	1,120	300	470	400
7. CONSTRUCTION PAPER AND PAPERBOARD						
Gypsum Linerboard	1,350	1,500	680	340	130	350
Construction Paper	2,540	1,850	350	270	70	1,160
Insulation & Hardboard	5,410	-	-	-	-	-
TOTAL CONSTRUCTION	9,300	3,350	1,030	610	200	1,510
TOTAL PAPER AND PAPERBOARD	90,800	23,570	10,550	3,670	4,700	4,650

Source: Table X-3, projected to 1983 by ADL using the methodology described in section X-C.

TABLE X-5

PROJECTED AVAILABILITY AND POTENTIAL RECOVERY OF MAJOR WASTE PAPER GRADES IN 1983

	Apparent Consumption of Original Products (Million tons)	Collectable Tonnage		Potential Recovery			Net Collectable Tonnage (Million tons)
		Million Tons	% of Apparent Consumption	Reused plus Exported (Million tons)	% of Apparent Consumption	% of Collectable Tonnage	
Old Corrugated Containers	25	21.6	86	11.5	46	53	10.1
News	13.6	10.5	77	4.5	43	43	6.0
Pulp Substitute & Deinking	41.3	5.4	13	5.1	12	93	0.3
Mixed	35.9[a]	27.6	76	4.6	13	17	23.0
Total U.S. Original Products	79.9[b]	65.1	61	25.7	32	39	39.4

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[a] Not included in total, since both pulp-substitute and deinking grades and mixed papers are assumed to be derived from the same original products (namely, printing and writing grades).

[b] Does not include waste paper delayed or diverted in end use; total U.S. consumption for period estimated at 90.8 million tons.

Source: ADL estimates of apparent consumption and calculations of recovery.

and pulp substitute grades and an under-utilization of news and mixed waste paper. (These estimates reflect our previous discussion regarding the commercial utility of the studied waste paper categories, hence their prospect for increased usage.)

The concentrated supply of OCC resulting from its high per capita consumption and usage pattern was an important consideration in our assessment of its potential reuse. Similarly, the projected cost of virgin market pulp was a major factor influencing our assessment of the high utilization rate for pulp substitute and high-grade deinking grades.

News, on the other hand, appears underutilized. As a percentage of the groundwood paper produced in the United States, its use is projected to reach about 30%, a sharp increase from the present level of about 15%; however, the utilization rate of old news is clouded by the large amount of imported newsprint.

Mixed waste is presently of limited commercial utility. Significant technological improvements, specifically in cleaning techniques, are required to increase the utilization of this grade.

Table X-6 shows the use of waste paper in 1973 by major paper stock category and the corresponding recycle rates in relation to U.S. paper production and consumption. Also listed is the potential usage of secondary fiber for 1977 and 1983.* Obviously, such projections are subject to error. Some of the key assumptions on which these projections were based were stated previously. Unforeseen variations from these assumptions will influence industry's response to secondary fiber usage. Overall, however, these projections indicate the potential of secondary fiber as an alternative raw material to support the industry's new and expanded production programs.

In the following paragraphs, we illustrate the rationale to derive the quantity of each waste paper grade used in each of the studied functional groups. The discussion is arranged by waste paper grade to facilitate the compilation of total waste paper usage.

D. REUSE OF OCC

OCC can be used in the manufacture of products in functional groups 1 (Containerboard), 4 (Folding Boxboard), 6 (Industrial Packaging), and 7 (Construction Paper and Paperboard). Containerboard represents the largest single application and opportunity for increased use of secondary fiber. Uses in other areas are either noncompetitive, such as in combination folding and nonbending boxboard, or presently hold a

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*Exports in 1983 are estimated at 2.1 million tons on the basis that the surplus supply in some states is more likely to be exported than reused domestically. Because of this assumption, the figure is considerably higher than the total of 1.1 million tons that one would obtain by adding the export forecasts given in Tables VII-10, -13, -17, and -20.

TABLE X-6

SUMMARY OF POTENTIAL RECOVERY RATES FOR SECONDARY FIBER IN 1973, 1977, and 1983

(millions of tons)

	1973	1977	1983
Paper and Paperboard			
Total Apparent Consumption	67.0	75.4	90.8
Total Production	61.7	69.2	83.9
Amount Recovered			
Old Corrugated Containers	5.6	7.7	11.5
News	2.7	3.1	4.5
Pulp Substitute & Deinking	3.4	4.0	5.1
Mixed	3.4	3.7	4.6
TOTAL	15.1	18.4	25.7
Exported	0.7	0.9[a]	2.1[c]
Domestic Use	14.4	17.5[b]	23.6
Recovery Rate (total recovered) ÷ total app. consumption)	22%	24%	28%
Consumption Rate (domestic use ÷ total production)	23%	24%	28%

[a] More recent published figures indicate that 1974 exports totaled 1.3 million tons; thus, the export estimate is probably low.

[b] This figure (from 1973 API Capacity Survey) is probably high, as 1974 Survey projects 16.0 million tons.

[c] Consists of approximately 0.9 MM tons OCC, 0.8 MM tons news, and 0.4 MM tons pulp substitute and deinking.

Sources: 1973 - API Capacity Survey data
1977 - API projections of total consumption (1973 Capacity Survey) and ADL estimates of waste paper exports
1983 - ADL estimates

dominant position, as in recycled tube and drum paper. Increased usage in these latter applications is tied more closely to demand for the original products than to penetration of S/F as a fiber substitute. Applications of OCC in each of the above functional groups are discussed below. The tonnages expected to be used in each group in 1983 have been summarized in Table X-4.

1. Containerboard

Use of OCC in containerboard can be either as 100% fiber furnish or as a fiber supplement to virgin fiber. The process economics and potential opportunities for OCC reuse in these applications are quite dissimilar.

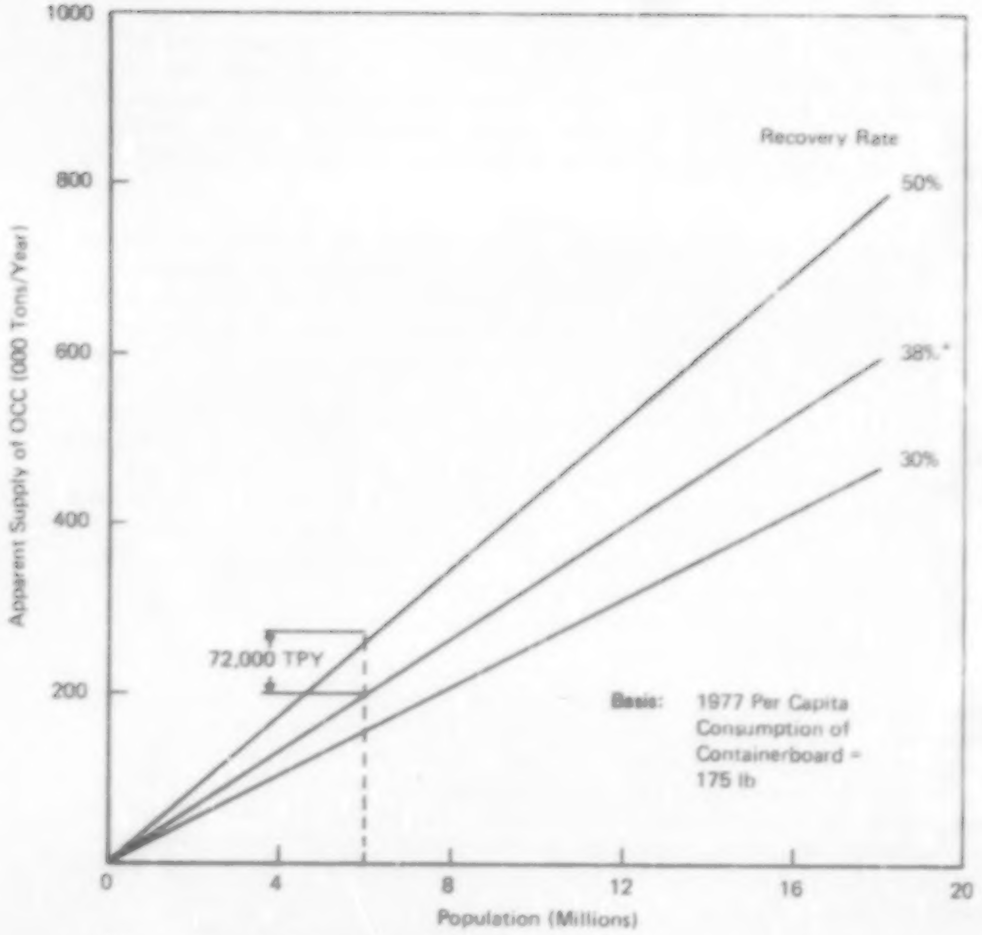
As the sole fiber source, OCC may be used in the manufacture of jute liner or bogus medium. The manufacturing technology and markets for these products are well established, and their ability to compete with virgin fiber products is sufficient to warrant more detailed evaluation by potential manufacturers.

The practical minimum capacity for a jute liner or bogus medium mill is about 300 tons per day, which is equivalent to about 120,000 tons per year of OCC. To estimate how many sites are available to generate the additional tonnage of OCC required to support a new mill, we shall use the concepts of the "90-minute-market" and the "S-M-S market" previously described.

As stated earlier, it is assumed that about 60% of the waste paper requirement would be available within the 90-minute market. These assumptions are critical to the estimated delivered cost of fiber to a proposed mill. From the projected 1977 containerboard consumption, we can derive the population required to generate the supply for a new facility based on 100% recycled fiber. Figure X-6 shows the relationship between population and the apparent supply of OCC for various recovery rates.

Suppose, for example, that we were considering locating a mill in an area containing a population of some six million within the 90-minute market, and that 38% of the corrugated containers used in the area were presently being recovered. To permit an economical plant size, we know that we must obtain at least 120,000 tons of OCC per year within the S-M-S market, in addition to that already being recovered. Sixty percent of this, or 72,000 tons per year, should come from the central 90-minute market. On Figure X-6, a vertical line is drawn through the 6-million point on the horizontal scale. From its intersection with the 38% recovery line, we extend the vertical line a distance equivalent to 72,000 tpy (vertical scale). This brings us somewhat above the 50% recovery line, which we have assumed to be the likely maximum rate, so the recoverable tonnage of OCC would appear to fall a little short of what is needed.

One should keep in mind that this graphical method is intended only for a preliminary screening of sites. Without site-specific infor-



*National Average Projected for 1977.

FIGURE X–6 RELATIONSHIP OF POPULATION TO APPARENT SUPPLY OF OCC AT VARIOUS RECOVERY RATES

mation on the quantity of OCC that is discarded and the current rate of recovery, the results are obviously very imprecise. Moreover, it might be practical to obtain more than 40% of the needed OCC from the surrounding S-M-S market, if it contains sufficient population and is not already supplying mills in other 90-minute markets. When these markets overlap, as they do throughout most of the northeastern United States, the problem becomes extremely complex.

Therefore, once preliminary selections of sites have been made, more precise figures on collectable tonnage and existing recovery rates must be derived for each area. Possible variations from national or regional averages should also be determined; for example, smaller population centers with recycle levels below the national or regional average may prove attractive, whereas larger population centers with above-average existing reuse or large quantities of exports may not be suitable.

Within the margin of error for our graphic estimating technique, Figure X-6 indicates that a 90-minute market with a population of somewhat more than six million should be able to support a mill of minimum economic size. Figure X-1 lists six 90-minute markets with populations of at least six million. Their total population was almost 60 million in 1972 and is considerably more now. By 1983, it should be more than enough to support the equivalent of ten additional recycled jute liner mills as the total consumption of containerboard increases to 25 million tons.* These mills would raise the consumption of OCC by about 1.2 million tons per year. Although the comparative ROI for the jute liner is substantially lower than that for virgin liner, we have assumed a high growth for this recycle application. The technical ability, the difference in the magnitude of the investment, and the economic accessibility of waste paper to support growth have prompted us to postulate this expansion.

We assume that all new 100% OCC-using capacity will be for jute liner and that no new bogus medium capacity will come on stream between 1977 and 1983. However, as shown in Table X-4, an increase in OCC use is expected in existing NSSC and combination medium mills. We do not intend this as a projection, but rather as an assumption to facilitate an estimate of total increase in OCC reuse; this assumption is not inconsistent with 1977 conditions of semi-chemical and bogus medium over-capacity.

OCC can also be used as a fiber supplement in the manufacture of all products contained in this functional group. In virgin kraft linerboard manufacture, it was shown to be economically attractive (Section IX) and technically practical in proportions up to 20% of the total fiber furnish (Section VIII). The sole reservation was that viable pulp mill capacity would not be idled to permit this substitution; those mills in which this scheme would be economically attractive would have an alternative on-site use for the diverted tonnage or, where it is economically and technically possible, would incrementally increase the production from their board machines. Although we did not derive the cost of making market pulp from the diverted linerboard pulp, technical problems would probably make this alternative unprofitable.

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* This statement assumes that the population in these six markets generates OCC at the national average rate. A more precise method of estimation on a regional basis is explained in Section VII.

We have not attempted to determine how many mills might find it technically and economically attractive to use OCC as a fiber supplement. Such a determination would require knowledge of the specific board machine, plant, and geographic region. In general, however, an incremental increase in board machine capacity is more often possible than incremental pulp mill expansion. Furthermore, the incremental supply of OCC required to support an economic scale of operation for supplemental use of OCC is less than half that required to supply a mill based upon 100% secondary fiber. Hence, there may be a number of board machines on which it is attractive to use OCC as a fiber supplement and where there are a number of areas from which to derive the necessary supply of OCC. Because of the large production capacity for kraft linerboard, even a modest penetration of OCC in this application would result in a significant increase in waste paper consumption.

By 1977, the amount of OCC used in this application is estimated to reach some 0.9 million tons, or about 30% of the theoretical maximum. If we assume penetration of this market as well as normal increased demand for the original product between 1977 and 1983, the quantity used in this application could increase to about 2 million tons, or about 60% of the theoretical maximum.

2. Folding Boxboard

Although old news is the principal waste paper grade used in folding boxboard, some OCC is also used; therefore, this product group is included in our discussion of OCC applications.

As stated previously, folding boxboard includes complementary as well as competitive products. In many applications for high-caliper board, the recycled product--combination board--is technically and economically preferable to SBS board; in low-caliper board applications, the converse is true. It is only in the caliper range between 14 and 18 points that these products compete. In recycled fiber products, virgin fiber is seldom blended with secondary fiber to make combination board; conversely, in SBS board, secondary fiber is seldom blended with virgin fiber. Hence, product substitution rather than fiber substitution influences the use of secondary fiber in this product category. The critical question therefore is: to what extent are the finished products interchanged, one for the other?

The industry has already demonstrated technological improvements in combination board machinery that will increase product quality. Also, alternative and higher-value applications for the bleached virgin kraft pulp used in SBS board are likely to increase the cost differential between these products. Hence, in the long term, recycled board products may capture a larger percentage of this total market. Through 1983, however, product substitution is expected to be nominal; therefore, the use of secondary fiber will be tied to the growth of traditional applications served by recycled board products. The apparent increased penetration of recycled board in the 1977-1983 period will reflect the declining growth of SBS, not product substitution.

OCC represents less than 20% of the total fiber furnish for combination board; thus, we anticipate no difficulties in obtaining sufficient supply to meet the fiber requirements of this application.

3. Industrial Packaging

OCC comprises about 50% of the total waste paper used in industrial packaging. Because of the high cost and scarcity of unbleached kraft market pulp, fully 80% of the total 0.6 million tons of production scheduled to come on stream between 1973 and 1977 will be tied to secondary fiber. We believe that much of the fiber substitution possible will be accomplished by 1977; hence, the increased usage between 1977 and 1983 will primarily result from market growth of original products rather than substantial additional penetration of secondary fiber into areas traditionally served by virgin fiber.

4. Construction Paper and Board

OCC usage in this group represents its third largest application. In 1973, about 750,000 tons (30% of the total 2.4 million tons of waste paper used in this application) was OCC.

Two dissimilar products are included in this functional group. The first, construction paper, is almost always made entirely of secondary fiber; hence, additional growth of OCC here is tied to the market demand for the original products. The second product, construction board, now contains virtually no secondary fiber, so OCC might find increased use as a replacement for virgin fiber. The partial substitution of OCC for virgin fiber in medium-density hardboard has been proved technically feasible, but we know of no company that now does this or plans to do so. Thus, the likely impact of such substitution is likely to be nominal through 1983, as reflected in our projections. However, in the longer term, construction board application could be a major use for additional waste paper.

E. REUSE OF OLD NEWS

Old news can be reused in groundwood papers and, to some extent, in virtually all other functional groups. Many of the opportunities for and constraints on its use are the same as for OCC; here we shall discuss only those uses that are uniquely applicable to news--specifically groundwood papers.

Newsprint represents the greatest single potential for increased use of old news because (a) it represents the largest segment of this category, and (b) old news can be used as either a 100% substitute or a partial replacement for virgin fiber. A third factor influencing the reuse of old news, not only in newsprint but also in other specific grades within and outside this functional group, is the large amount of imported newsprint; these imports cause the available supply to be substantially more than can potentially be reused in groundwood papers.

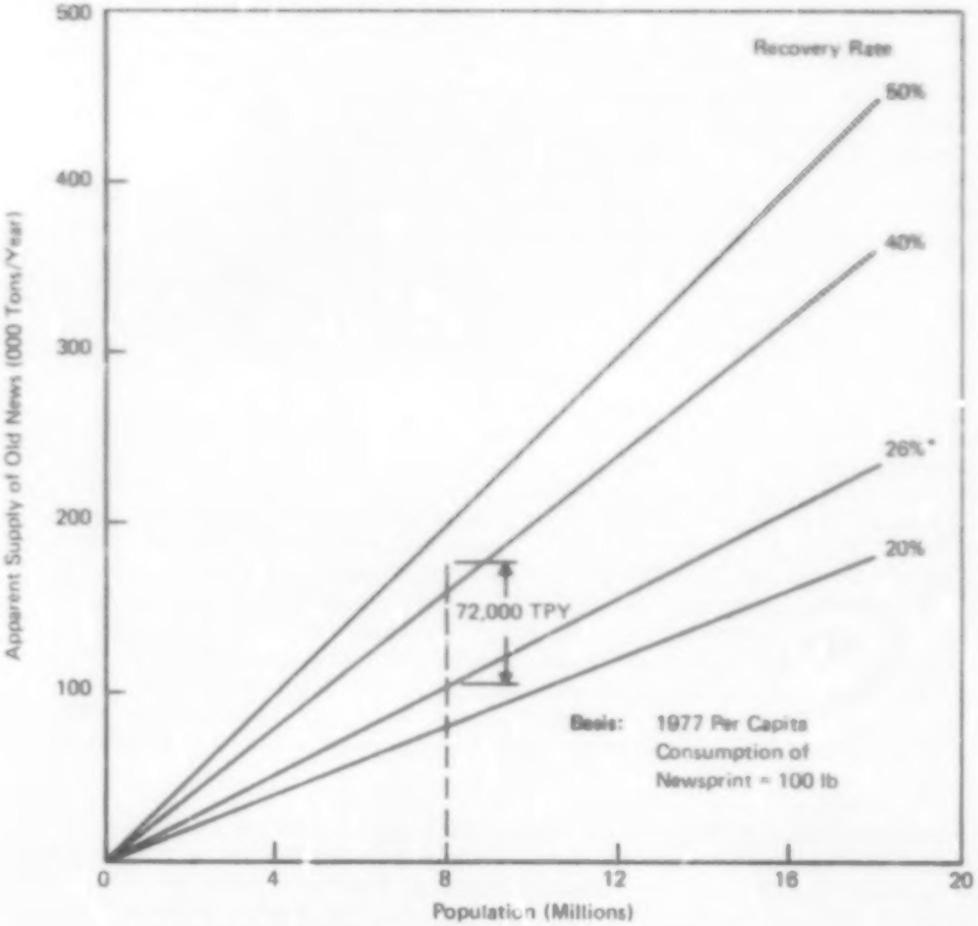
Production of 100% recycled newsprint is an accepted industry practice and is economically attractive. The major factor in considering reuse of news beyond 1977 is the availability of a sufficient quantity in a given area. As discussed in Section IX a recycled newsprint mill should produce at least 100,000 tons per year to be economically attractive. Because of fiber losses and moisture differences, this would require 120,000 tpy of old news.

Candidate sites can be screened in the same way as earlier described for OCC. Projections for 1977 indicate an apparent consumption of newsprint of 100 pounds per capita and an average recovery rate of 26%. Figure X-7 shows the theoretical amount of old news obtainable from a given population at various recovery rates. Suppose that the candidate site has a population of eight million within its 90-minute market. Of the 120,000 tpy of old news needed, 60% (72,000 tpy) should be recoverable from this area. A vertical line is drawn through the 8-million point on the population scale and extended upward past its intersection with the 26% recovery line a distance equivalent to 72,000 on the vertical scale. The line is found to terminate about half way between the 40% and 50% recovery lines, indicating that the necessary supply would be obtainable.

Further examination of Figure X-7 shows that it should be possible to obtain the desired amount of old news from a population as small as six million without exceeding the assumed maximum recovery rate of 50%. Reference to population figures for the various 90-minute markets (Table X-1) then shows that six have populations of at least six million and should therefore be able to support additional recycled newsprint mills. (The ability of the surrounding S-M-S markets to supply the remaining 40% of the fiber requirements would, of course, have to be verified.)

We must again emphasize that this technique permits a preliminary screening of candidate mill locations but is very imprecise. A detailed survey of collectable tonnage and existing consumption and reuse patterns in a prospective location is necessary. As indicated in Figure X-7, it is possible that areas with smaller populations but lower existing recovery rates could be attractive sites, while larger centers with high existing recovery might not provide sufficient additional fiber to support a mill.

Supplementary secondary fiber is economically attractive and technically practical at any fraction of total product, with the economic limitation



*National Average Projected for 1977.

FIGURE X–7 RELATIONSHIP OF POPULATION TO APPARENT SUPPLY OF OLD NEWS AT VARIOUS RECOVERY RATES

that viable pulp mill capacity would not be idled to accommodate supplementary news. Thus, the use of supplementary secondary fiber for newsprint manufacture is applicable to those mills where: (a) obsolete pulping capacity would be retired without reducing machine capacity, (b) there is an alternate use or market for diverted virgin pulp, or (c) it is economically attractive to incrementally increase machine capacity independent of pulp mill capacity. We have not attempted to determine how many mills would meet these conditions.

The extent to which news will be used as a fiber supplement in virgin groundwood pulp is difficult to predict. We have assumed that it would be well exploited by 1977, and thus we have not projected further growth beyond that time. However, the production of virgin groundwood pulp requires much energy, and increases in the cost of energy could improve the relative economics of using secondary fiber. A lower concentration of the residual collectable tonnage of news could become available at existing economic levels simply through increased demand. Alternatively, higher concentrations could be obtained by drawing from a larger area or increasing prices paid within a given area, if rising energy costs made it attractive to use supplementary news even at higher than existing costs. Quantitative speculation in this area is outside the scope of this analysis.

The changing economics of groundwood pulping are particularly important in groundwood printing papers and groundwood specialties. These grades are integrated to a large extent to old and small groundwood mills, which are presently only marginally economical and would be the most badly hurt by rising energy costs. Replacing groundwood with news in these mills would decrease energy consumption. It would also provide an opportunity to obtain both mechanical and chemical fiber and thus reduce dependence upon purchased chemical fiber. The potential use of news in this application would depend on mill size and accessibility of fiber as determined by mill location. A potential market of 0.3 to 0.5 million tons of news consumption is reasonable.

We have projected an increased consumption of 0.6 million tons of news in 100% recycled newsprint from 1977 to 1983 and 0.3 million tons in other products due to their natural growth, making a total increase in annual consumption of 0.9 million tons. (See Tables X-3 and -4.) Any increase in supplementary news after 1977 would be in addition to this.

Increased penetration would require a change in the relative economics of supplementary news, as noted above, or an increase in fiber supply to support 100% recycled newsprint without decreasing present profitability levels. Under existing conditions, fiber supply for a given site could be increased only by drawing from a larger area, which would increase transportation costs, or by stimulating a higher recovery rate within a given area, which implies increased news prices.

Marginal increases in concentration of available news to support a 100% recycled newsprint mill might be possible by substituting mixed waste for news in recycled product grades that use both. This would not directly increase overall waste paper usage, but it could indirectly affect penetration if it made a sufficient concentration of news available to support a recycled newsprint mill that otherwise would not be feasible.

F. REUSE OF PULP SUBSTITUTES AND HIGH-GRADE DEINKING

Pulp substitutes and high-grade deinking grades find a ready market in two areas: (1) as a replacement for, or supplement to, market pulp in nonintegrated mills that make products in the Tissue or Printing and Writing functional groups, and (2) to a lesser extent, as a partial fiber supply for recycled products in the Folding Boxboard, Industrial Packaging, and Construction Paper and Board functional groups.

P/S can provide the entire fiber furnish for some grades of printing and writing papers and is suitable for partial substitution for virgin fiber pulp in most of the other grades in this functional group. It is primarily a replacement for hardwood pulp, although some P/S grade mixes can be substituted for softwood. The precise suitability varies with the P/S grade mix as well as with desired product specifications and basis weight.

The partial substitution of P/S in sanitary tissue gives an equivalent, or even possibly superior, product because of the softness contributed by reworked fiber. Complete substitution is possible but usually produces inadequate strength for efficient converting operations. The typical practice in using P/S for sanitary tissue is to use just enough virgin softwood fiber to impart sufficient strength for successful converting performance.

These waste paper grades are primarily obtained fron converters, and a high percentage of the total available supply is recovered.

Since a market exists for much higher volumes of P/S, increased penetration is limited solely by the available supply. Transportation cost is a relatively minor factor in P/S reuse because of the high value of the basic material. Geographic distribution is also of minor importance in considering available fiber supply. We believe the high utilization rate projected for the 1973-77 period will continue through 1983. Assuming that reuse will grow in proportion to the increased supply from the traditional source, additional reuse will be about 0.9 million tons higher in 1983 than in 1973. (See Tables X-3 and -4.) We believe usage would increase substantially if additional supply sources could be exploited. The main constraints are social and technical considerations of original product consumption and disposal. Increased supply depends on diverting P/S grades from the mixed waste stream; this, in turn, will require social change to initiate source segregation (i.e., separation of P/S grades at the point of consumption, through classification of office waste, for example) or technological developments for separating P/S grades from mixed waste.

G. REUSE OF MIXED WASTE PAPER

The existing mixed waste stream represents the opposite conditions from P/S; it is low in value, and its applications are limited by the constraints of fiber substitutability. Because of the low value, transportation costs represent a large portion of the delivered cost. However, an abundant supply is available to meet existing applications, and the geographic distribution of collectable tonnage is not a factor in its growth.

Mixed waste is used to some extent in recycled products from all functional groups. The important uses are in folding boxboard, industrial packaging papers, and construction papers. We have projected a growth of 0.9 million tons from 1977 to 1983, based on the natural growth of the noncompetitive products in which mixed waste is used. (See Tables X-3 and -4.)

There are no existing markets to directly increase reuse of mixed waste. Increased penetration will depend on reclassification of the mixed waste stream, either by preventing higher P/S grades from entering the mixed waste in the first place, or through technical developments which will allow mixed waste to be physically reclassified into higher grades that do have existing uses. As noted previously, the most immediate use would be as a source of P/S waste grades.

Mixed waste might also find increased use as a substitute for waste news and OCC if some upgrading is technically feasible. This increase would be in the Folding Boxboard, Industrial Packaging, and Construction Paper groups, where a variety of waste paper furnishes are typically used in the recycled grades. Some upgraded mixed waste might also be used directly as a partial furnish for containerboard or newsprint. In any case, greater use of mixed waste would represent an overall increase in secondary fiber penetration only if the waste news and OCC replaced were used to make more recycled newsprint or containerboard.

At historical prices for mixed waste paper ($3- $10 per ton, f.o.b. dealer), its availability is threatened by its use as a replacement for fossil fuel. Mixed waste paper has a net fuel value of about 4,000 Btu per pound, or about 8 million Btu per ton. Therefore, at current fuel costs of about $2.00 per million Btu, its fuel replacement value is $16 per ton--substantially more than the price paid by the paper mill. As a result, a support price could be created for mixed waste, which would increase the cost of papermaking and lower the profitability of recycled products made from this material. It would be in the industry's best interest to upgrade the utility of this material, so that it would be too valuable to burn.

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